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Northern Long Lake Area

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D.U. Kresz and B. Zayachivsky

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Foreword

Detailed geological information, a compilation of presently known economic deposits, and past exploration activity are essential for effective mineral exploration and as a basis for land use potential evaluation. Prior to 1988, the information available for the northern Long Lake area was limited to a reconnaissance and preliminary level.

The area is situated immediately east of the Geraldton gold camp, which produced over three million ounces of gold between 1934 and 1970. It hosts several gold occurrences which, at the time of writing, were being re-evaluated by various companies. The Beardmore–Geraldton–Longlac area is considered to have good potential for further discovery of gold and other mineral resources.

V.G. Milne

Director
Ontario Geological Survey

Abstract

This report describes the geology, mineral deposits and exploration history of the northern Long Lake area, which includes Houck, Oakes, Croll and Abrey townships; the northern half of Coltham Township; the McBean Lake area, and Long Lake Indian Reserves No. 58 and Ginoogaming First Nation (formerly Indian Reserve No. 77).

The bedrock underlying the map area is of Precambrian age and belongs to the eastern Wabigoon and Quetico subprovinces of the Superior Structural Province.

The oldest rocks in the area belong to an Archean supracrustal sequence of metamorphosed volcanic and sedimentary rocks, which are intruded by granitic stocks. The volcanic assemblage consists of 1) tholeiitic, mafic pillowed and massive flows that are commonly amygdaloidal—these are intruded by related gabbro sills and lenticular bodies; and 2) lesser felsic rocks that are represented by feldspar-quartz porphyry bodies in Abrey Township, and by minor fragmental deposits of lapilli tuff and tuff breccia that occur within the mafic metavolcanic rocks. Subvolcanic feldspar and quartz-feldspar porphyry dikes occur throughout the map area.

The sedimentary assemblage is represented mainly by well-stratified epiclastic metasediments characteristic of a submarine fan association. These include thinly to thickly bedded arenite, wacke, siltstone and mudstone of turbiditic facies that commonly display grain size gradation. Compositionally, the sandstones range from relatively mature quartzofeldspathic arenites to immature wackes; the latter are commonly found as chlorite and sericite schists or as amphibole schists depending on the prevailing metamorphic conditions. Associated with the turbiditic sandstones are resedimented conglomerates and magnetite iron formation. In Houck Township, a unit of polymictic conglomerate of fluvial-alluvial facies has been recognized.

The volcanic-sedimentary assemblage is intruded by a small pretectonic stock, the Theresa stock, of tonalitic composition in Abrey Township; and by a syntectonic pluton, the Croll Lake stock, of granodioritic affinity.

During the Proterozoic, diabase and lesser alkalic dikes have intruded the Archean crust.

The structure of the map area is similar to the rest of the Beardmore–Geraldton belt; a tectono-stratigraphic assemblage characterized, on a regional scale, by the repetitive alternation of several east-trending volcanic and sedimentary units representing an imbricate thrust stack. This terrane marks the transition between the predominantly volcanic Wabigoon Subprovince in the north, and the metasedimentary Quetico Subprovince in the south.

Within the map area, the north-facing rock units are steeply to vertically dipping in the north and become overturned with southerly dips of intermediate to steep angles in the south. The regional metamorphic foliation parallels the trend of rock units.

Two major deformation zones associated with regional east-trending faults, the Bankfield–Tombill fault in the south and the Burrows River fault in the north, are characterized by a system of shear zones that occur over a width of up to several kilometres. Kinematic indicators point towards an oblique dextral sense of movement, suggesting a relative motion of the north block over the south. A prominent hinge fault, with increasing displacment to the south, underlies Long Lake and has resulted in the relative uplift of the fault block east of Long Lake, as indicated by higher metamorphic grades. Rocks west of Long Lake have been subjected to regional metamorphism of greenschist type whereas, east of Long Lake, mineral assemblages typical of upper greenschist to lower amphibolite conditions are present. A thermal aureole is present around the Croll Lake stock.

The economic potential of the area lies mostly in gold. The map area is situated immediately to the east of the Geraldton gold camp, which produced over three million ounces of gold between 1934 and 1970. In the 1980s, the region has received considerable new interest with respect to gold exploration.

Although gold has never been produced within the confines of the map area, mineralization is present in many occurrences that lie on the same structures that host the gold deposits at Geraldton. Gold deposits are found to be spatially associated with

1) specific lithologic units, 2) prominant fault-related deformation zones, and 3) iron formation, all of which probably provide a controls on mineralization. Gold has been found associated with 1) quartz veins that occur mostly in shear zones, 2) sulphide-bearing discrete shear zones and 3) chert horizons. Of particular significance is the localization of gold in iron formation which has been replaced by sulphides in the presence of quartz veins.

With regard to mineral development, the area is very well situated with respect to communication, transportation and energy sources.

Precambrian geology, northern Long Lake area, by D.U. Kresz and B. Zayachivsky, Ontario Geological Survey, Report 273, 77p.

Résumé

Ce rapport décrit la géologie, les dépôts minéraux et l'histoire de l'exploration minière dans le secteur nord de la région de Long Lake. Le secteur cartographié comprend les cantons de Houck, Oakes, Croll et Abrey, la moitié nord du canton de Coltham, la zone autour de McBean Lake ainsi que les terres de la Première Nation de Ginoogaming et la réserve indienne Long Lake No 58. Le socle rocheux du secteur cartographié est d'âge précambrien et appartient à la partie orientale des sous-provinces de Wabigoon et de Quetico au sein de la province structurale du Lac Supérieur.

Les roches les plus anciennes du secteur cartographié appartiennent à une série de roches supracrustales archéennes composées de roches volcaniques et sédimentaires métamorphisées. Cette série est intrudée par des massifs granitiques. L'assemblage volcanique est constitué 1) de coulées mafiques tholéiitiques massives et à coussinets qui sont souvent amygdalaires. Ces coulées sont intrudées par des filons-couche et des masses lenticulaires de gabbro connexes. 2) Des roches felsiques, en moindre quantité, sont représentées par des masses de porphyre à quartz et feldspath dans le canton d'Abrey et par quelques unités de tufs à lapilli et tufs-brèche parmi les roches métavolcaniques mafiques. Des dykes subvolcaniques de porphyre à quartz et feldspath sont communs dans tout le secteur cartographié.

L'assemblage sédimentaire est représenté surtout par des métasédiments épiclastiques caractéristiques d'une association de delta de canyon sous-marin. Celui-ci comprend des stratifications fines à épaisses d'arénites, de grauwacke, de siltstone et de mudstone de faciès à turbidites qui présentent souvent un granoclassement. La composition de ces grès varie partir d'arénites quartzo-feldspathiques relativement évoluées jusqu'aux grauwackes peu évolués. Ces derniers se retrouvent souvent sous forme de schistes à chlorite et séricite ou amphibole lorsque le degré de métamorphisme est plus élevé. Des conglomérats resédimentés et des formations de fer riches en magnétite sont associés avec les grès turbiditiques. Dans le canton de Houck, a été identifiée, une unité de conglomérat polygénique de faciès fluvio-alluvial.

Dans le canton d'Abrey, l'assemblage volcano-sédimentaire est intrudé par un petit massif anté-orogénique (massif de Theresa) de composition tonalitique, et par un pluton syntectonique (le massif de Croll Lake) de caractère granodioritique.

Au cours du Protérozoïque, des dykes de diabase et quelques dykes alcalins ont intrudé le socle archéen.

La structure géologique dans la zone cartographiée est similaire au reste de la ceinture de Beardmore–Geraldton. Celle-ci représente un assemblage tectono-stratigraphique caractérise à l'échelle régionale, par l'alternance de plusieurs unités volcaniques et sédimentaires orientées vers l'est. Cette alternance forme une structure imbriquée par charriage qui marque la transition entre la sous-province de Wabigoon, au nord, à prédominance volcanique et la sous-province sédimentaire de Quético, au sud.

Au sein de la zone cartographiée, les unités lithologiques polarité nord, ont un pendage fortement redressé à vertical dans la partie nord, tandis que plus au sud, ces unités sont inversées avec des pendages modérés à forts vers le sud. La schistosité est parallèle à l'orientation des unités lithologiques.

Deux grandes zones de déformation ont été définies. Celles-ci sont associées aux failles régionales de Bankfield–Tombill au sud et de Burrows River au nord et sont caractérisées par un système de zones de cisaillement qui s'étend sur une largeur allant jusqu'à plusieurs kilomètres. Les indicateurs cinématiques indiquent un mouvement dextre suggérant le déplacement relatif du bloc nord par dessus le bloc sud. Une faille normale dont le rejet augmente vers le sud est présente le long de Long Lake et a produit le soul vement du bloc est par rapport au bloc ouest tel qu'indiqué par un degré de métamorphisme plus élevé à l'est de la faille. Les roches l'ouest de Long Lake ont subi un métamorphisme du type des schistes verts. En ce qui concerne les roches à l'est de Long Lake, les assemblages minéralogiques indiquent un faciès de schistes verts supérieur à amphibolite inférieur. Une auréole de métamorphisme de contact est présente autour du massif de Croll Lake.

Le potentiel économique concerne surtout l'or. La zone cartographiée est située directement à l'est du camp minier de Geraldton qui a jadis produit trois millions

d'onces d'or entre 1934 et 1970. Dans le courant des années 1980, la région a été de nouveau intensément explorée pour l'or.

Bien que l'or n'ait jamais été miné au sein du périmètre cartographié, de nombreux indices minéralisés ont été signalés dans les mêmes structures qui renferment les gisements d'or de Geraldton. Les gîtes d'or se trouvent associés avec 1) des unités lithologiques spécifiques, 2) des zones de déformation associées à des failles et 3) des formations de fer. Toutes ces structures ont probablement joué un rôle concernant la minéralisation. L'or a été trouvé associé avec 1) des veines de quartz que l'on trouve dans des zones de cisaillement, 2) des zones cisaillées minéralisées avec des sulfures et 3) des cherts. Il est intéressant de signaler que l'or est concentré dans les formations de fer ayant subi un remplacement par des sulfures en la présence de veines de quartz.

En ce qui concerne le développement des ressources minières, la zone cartographiée est favorisée par de bonnes voies d'accès et des sources d'énergie proches.

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Precambrian Geology
Northern Long Lake Area

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Manuscript approved for publication by B. Dressler, Supervising Geologist, Precambrian Geology Section, Ontario Geological Survey, February 23, 1989. Report published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Introduction

LOCATION AND ACCESS

The map area is situated at the northern part of Long Lake and comprises the townships of Houck, Oakes, Croll, Abrey, and the northern half of Coltham Township. The McBean Lake area, Long Lake Indian Reserve No. 58, the western part of Ginoogaming First Nation (formerly Indian Reserve No. 77) and the eastern part of McQuesten Township, adjoining the area mapped by Beakhouse and Chevalier (1983a), were also mapped. The area is bounded by latitudes 49°37′30″N and 49°50′25″N, and longitudes 86°32′50″W and 86°48′50″W; it covers 520 km^2 (Figure 1). Longlac, the nearest town, is situated at the eastern boundary of the map area. The city of Thunder Bay is 310 km southwest of Longlac via Route 11 of the Trans-Canada Highway.

Access to the map area is very good. Route 11 of the Trans-Canada Highway and the Canadian National Railway (CNR) transect the map area; the Trans-Canada Pipelines' right-of-way passes through Houck and Oakes townships. Access to the eastern part of the map area is also provided by a lumber road that links Longlac to Terrace Bay. A number of secondary roads provide access to various parts of the area and to Long Lake. A large part of the map area is accessible by light watercraft from Long Lake, Kenogamisis Lake and the Kenogamisis River.

PRESENT GEOLOGICAL SURVEY

The field work carried out during the summer of 1987 consisted of mapping the Precambrian bedrock and its mineral deposits. Pace-and-compass traverses were run at 300 to 400 m intervals; however, every possible effort was made to visit all areas of rock exposure recognized on aerial photographs. Geology is also tied to all roads, the CNR, the Trans-Canada Pipelines' right-of-way, electrical power transmission lines and the shorelines of all lakes. Recent exploration grid lines, as well as old bush roads and trails, have also been used to a large extent. Geology is not tied to surveyed or unsurveyed claim or township lines. Vertical aerial photographs at a scale of 1 inch to 1/4 mile (1:15 840) provided by the Surveys and Mapping Branch, Ontario Ministry of Natural Resources, were used in traverse planning and in plotting coded information in the field.

All field data have been transferred to 1:15 840 scale base maps derived from Forest Resources Inventory maps on which information changes were made during the course of mapping. A detailed geological map has been prepared at a scale of 1:315 (*see* Figure 7 (back pocket)) for a small area which received considerable overburden stripping for mineral exploration purposes.

A large number of rock samples were collected in the process of mapping; of these, 84 were submitted for assays, principally gold and silver; 115 were submitted

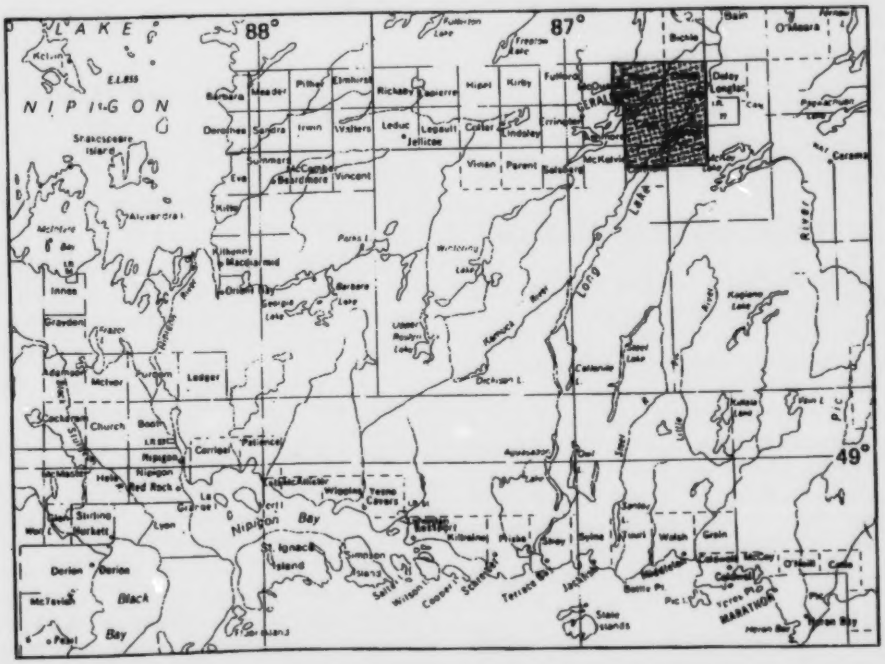

Figure 1. Key map showing location of the northern Long Lake area, scale 1:1 584 000.

for thin sectioning and 29 for whole-rock analysis. A summary of field work article (Kresz and Zayachivsky 1987) was published in December 1987. Map 2538 and Map 2539 (Kresz et al. 1990a, 1990b) were issued in 1990 by the Ontario Geological Survey.

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The authors were ably assisted by H.S. Oiye, K.L. Braun, D.R. Chang, M.L. Dolan and M.T.D. Wingate. As senior assistant, H.S. Oiye mapped about one-third of the area. The other assistants ran independent traverses during the later part of the field season.

Permission to map within the confines of Long Lake Indian Reserve No. 58 and Ginoogaming First Nation was obtained from each band council.

Much appreciated technical assistance was provided by the Ministry of Natural Resources in Geraldton.

PHYSIOGRAPHY

The area has a topography typical of the peneplained Precambrian Shield and the landforms are characteristic of glaciated terrains in northwestern Ontario, with hummocky ground moraine, kame and esker deposits, and drumlins. Long Lake lies at an elevation of 312 m above sea level. The local relief is marked by low undulating hills and rock knobs which do not exceed a maximum elevation of 70 m above the elevation of Long Lake. Numerous lakes occur throughout the area; the largest are Long Lake and Kenogamisis Lake. The area is poorly drained in many places, particularly in the western half of the map area where much of the surface is covered with swamp, marsh and muskeg.

The map area is situated within the arctic watershed and is drained by the Kenogami River via the Kenogamisis River, the Making Ground River and lesser streams which flow into Long Lake.

PREVIOUS GEOLOGICAL WORK

The first gold discovery in the Geraldton area—made in 1931—led to the first government-sponsored systematic geological survey of Lindsley, Errington and Ashmore townships by E.L. Bruce in 1934 (Bruce 1935). Previous to that survey, all investigations were exploratory and of a reconnaissance nature. In 1916, A.G. Burrows (1917) undertook a general examination of the area situated between Jellicoe and Long Lake along the Canadian Northern Railway. Prior to 1917, a number of geologists including Robert Bell, E.V. Neelands, A.L. Parson, A.P. Coleman and T.L. Tanton, traversed Long Lake from the south towards Kenogamisis Lake (Fairbairn 1938).

In 1936, H.W. Fairbairn mapped the northern Long Lake area, including the entire area mapped during the present survey (Fairbairn 1938), while R.D. Macdonald mapped the Pagwachuan Lake area in 1937 (Macdonald 1938). Their work is compiled on Map 41b which accompanies their report. In 1939, R.D. Macdonald mapped the Kenogamisis Lake area to the south of Bruce's (1935) mapping, including the western part of Coltham Township (Macdonald 1942). The following year, Macdonald mapped Kirby, Fulford, McQuesten and Houck townships (Macdonald 1943); Kirby, Fulford and western McQuesten townships were later remapped by G.P. Beakhouse (1989). The establishment of a major gold camp in Geraldton prompted the remapping of Errington Township by Pye (1952), and of Ashmore Township by Horwood and Pye (1955) who produced comprehensive reports on their work that include detailed descriptions of the underground mine geology as well as of gold mineralization.

Thematic studies pertaining to gold were undertaken by A.J. Macdonald in the Geraldton area (Macdonald 1982, 1983a, 1983b, 1984). Lavigne (1983) did a metallogenic investigation in the area between Geraldton and Longlac, while Buck and Williams (1984) conducted structural studies in the Geraldton area. Williams (1986, 1987) carried out a regional structural study of the general Beardmore–Geraldton area.

The map area is included on the compilation map of the Tashota–Geraldton area (Pye et al. 1965), on a revised compilation map of the Geraldton area (Stott 1984a) and on the Ontario Department of Mines–Geological Survey of Canada (ODM–GSC) Aeromagnetic Series Maps 7102G, 2150G and 2151G (ODM–GSC 1963a, 1963b, 1965).

Table 2 lists assessment work data on file with the Ontario Geological Survey in Toronto and with the Resident Geologist's office in Thunder Bay as of July 1987.

EXPLORATION HISTORY

Gold was discovered in the Geraldton area in 1931 (Horwood and Pye 1955). The discovery initiated a staking rush. As a result, many gold occurrences were discovered in the map area.

Recently renewed interest in gold contributed to a second staking rush in the 1980s, resulting in the re-evaluation of known gold occurrences and some new discoveries.

No mining activity has taken place in the map area. The Geraldton gold camp, however, lies just west of the map area and produced over 3 million ounces of gold and 240 000 ounces of silver between 1934 and 1970 (Mason and McConnell 1983). The Theresa Mine, located immediately east of the map area, produced 4785 ounces of gold and 202 ounces of silver during intermittent operation from 1935 to 1955 (Mason and McConnell 1983). Some recent activity at the Theresa Mine by Duration Mines Ltd. and Locator Explorations Ltd. has included the dewatering of the old No. 3 mine shaft and underground drilling (*The Northern Miner*, November 16, 1987).

TOPONYMS

Place names used in previous geological and mining company reports by prospectors and local residents may vary from official usage. Listed below are alternative names to official names shown on the northern Long Lake maps (back pocket), all of which have been used in the past.

Official Usage	Alternate Usage
1. Kenogami River	English River
2. Kenogamisis Lake	Little Longlac
3. Long Lake	Longlac
4. Making Ground River	Suicide River
5. Skinner Lake	Strathy's Pond
6. Longlac (town of)	Longuelac

General Geology

The northern Long Lake area is situated in the eastern part of the Archean Wabigoon Subprovince (Goodwin 1970) according to the Wabigoon–Quetico subprovince boundary as defined by Ayres (1969). It is part of a tectono-stratigraphic assemblage known as the Beardmore–Geraldton belt (Ayres 1969). East of Lake Nipigon, the Beardmore–Geraldton belt is about 180 m long and 30 km wide; it is bounded to the north by the Tashota–Onaman metavolcanic-plutonic domain (Amukun 1980; Mason and White 1986), and to the south by the Quetico metasedimentary terrane.

The Beardmore–Geraldton belt consists of a series of repetitive east-trending mafic metavolcanic and metasedimentary units; the repetitive character of the units is believed to represent an imbricated stack of thrust slices from a mafic volcanic-sedimentary sequence (Williams 1987; Devaney and Williams, 1989). Within the map area, the supracrustal rocks of this north-facing tectono-stratigraphic succession have been subdivided into three volcanic-sedimentary unit pairs, informally referred to as the Northern, Central and Southern volcanic and sedimentary units (Figure 2). A smaller volcanic unit is situated within the Southern sedimentary unit and is informally referred to as the Eldee Lake volcanic unit.

The metavolcanic rocks are represented by massive and pillowed flows which are commonly amygdaloidal. The bulk of the sedimentary rocks consists of turbiditic sandstones with locally interbedded lenses of conglomerate and associated magnetite iron formation. Con-

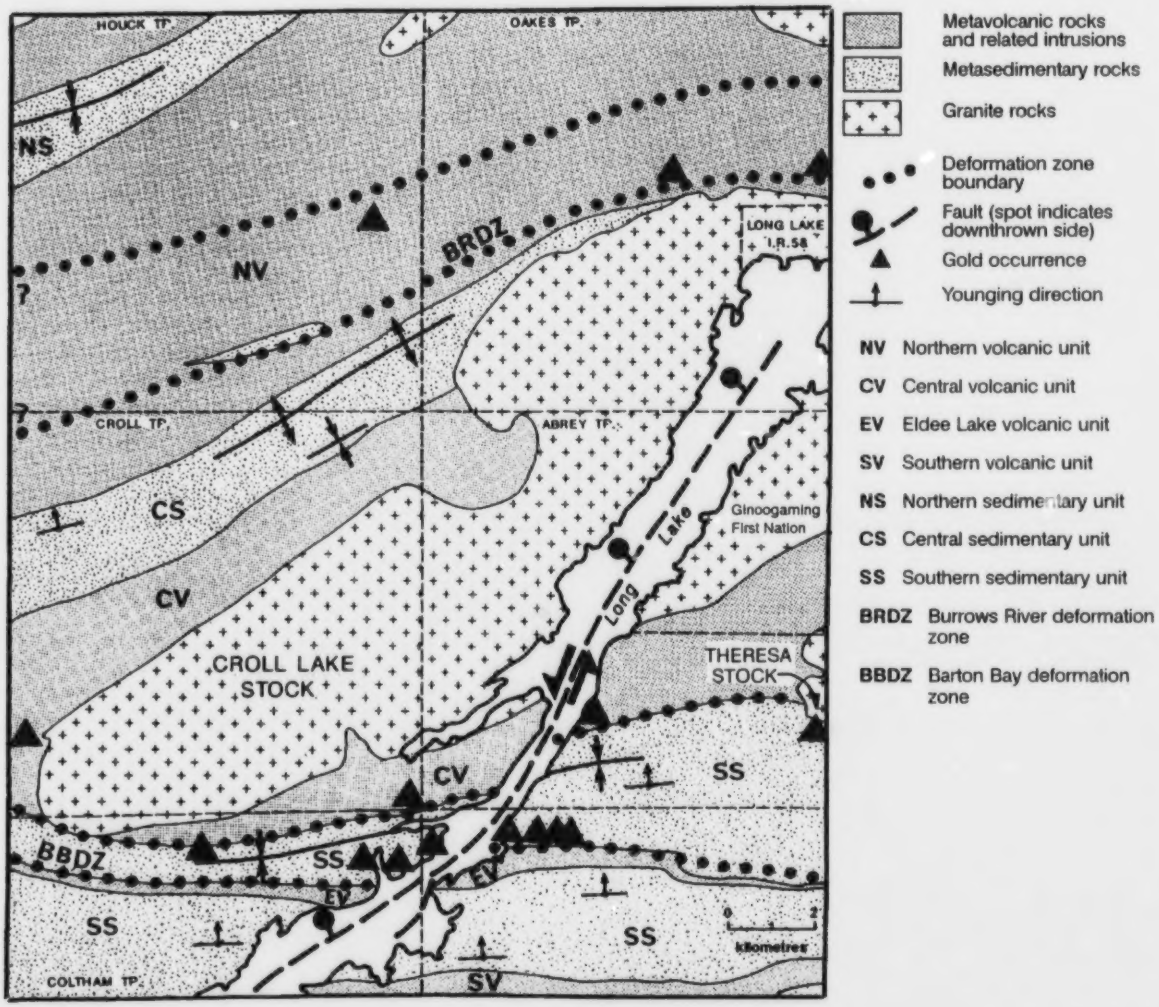

HOUCK TP.
OAKES TP.
CROLL TP.
ABREY TP.
COLTHAM TP.
NS
NV
BRDZ
CS
CV
CROLL LAKE STOCK
LONG LAKE I.R.58
Long Lake
Ginoogaming First Nation
THERESA STOCK
SS
BBDZ
EV
SV
?
0 1 2
kilometres
Metavolcanic rocks and related intrusions
Metasedimentary rocks
Granite rocks
Deformation zone boundary
Fault (spot indicates downthrown side)
Gold occurrence
Younging direction
NV Northern volcanic unit
CV Central volcanic unit
EV Eldee Lake volcanic unit
SV Southern volcanic unit
NS Northern sedimentary unit
CS Central sedimentary unit
SS Southern sedimentary unit
BRDZ Burrows River deformation zone
BBDZ Barton Bay deformation zone

Figure 2. Generalized geology of the northern Long Lake area; the major lithologic units shown are informal.

Table 1. Table of lithologic units for the northern Long Lake area.

PHANEROZOIC
  CENOZOIC
    QUATERNARY
      HOLOCENE
        Stream and lake deposits, peat
      PLEISTOCENE
        Till, glaciofluvial (sand and gravel), and glaciolacustrine (varved clay) deposits

UNCONFORMITY

PRECAMBRIAN
  PROTEROZOIC
    Intrusive Rocks
      Diabase, plagioclase porphyritic diabase, lamprophyre, trachyte, latite, peridotite, diatreme(?) breccia

INTRUSIVE CONTACT

  ARCHEAN
    Felsic to Intermediate Intrusive Rocks (Granitic)
      Quartz diorite, tonalite, quartz monzodiorite, granodiorite, monzonite, quartz monzonite, granite, feldspar and quartz porphyries, aplite
    Felsic Intrusive Rocks (Hypabyssal Intrusions)
      Feldspar porphyry, quartz-feldspar porphyry
    Mafic and Ultramafic Intrusive Rocks
      Gabbro, cumulate-textured mafic to ultramafic rocks

INTRUSIVE CONTACT

    Supracrustal Rocks[a]
      Chemical Metasediments
      Magnetite iron formation, chert
      Epiclastic Metasediments
      Turbidite association: feldspathic arenite, quartzofeldspathic wacke, lithic wacke, siltstone, slate, conglomerate
      Non-marine association: conglomerate
      Felsic to Intermediate Metavolcanic Rocks
      Tuff breccia, lapilli tuff, ash and crystal tuff, quartz-feldspar porphyry
      Mafic Metavolcanic Rocks
      Massive and pillowed (commonly amygdaloidal) flows and related breccias, pyroclastic rocks (lapilli tuff and tuff breccia)

[a] *The order in which the major rock groups are listed does not imply any age relationships as units are intercalated, and their contacts may be conformable, nonconformable or faulted.*

glomerate of alluvial-fluvial association has been recognized in Houck Township. Felsic metavolcanic rocks have been found in several places, but their exposed deposits are of a much more limited extent. Mafic intrusive rocks (gabbro) are found associated with the metavolcanic rocks. Coarse-grained gabbros to pyroxenites with cumulate textures are hosted by sedimentary rocks in northern Coltham Township and are believed to have been tectonically emplaced.

Fine-grained felsic dikes of quartz-feldspar and feldspar porphyry are found cutting all supracrustal rock types. The supracrustal rocks are intruded by a small granodiorite and tonalite stock which is, in part, exposed in eastern Abrey Township and by the granodioritic Croll Lake stock. During the Proterozoic, all Archean rocks have been intruded by north- to northwest-striking diabase dikes that probably belong to two distinct swarms, and by lesser alkalic dikes that include syenite, lamprophyre and carbonatized mica peridotite. Unconsolidated deposits of Pleistocene age, represented by till, glaciofluvial sand and gravel, and glaciolacustrine clay, uncomformably overlie the peneplained Precambrian rocks. Table 1 lists the lithologic units that occur in the map area.

The major structures associated with the Archean rocks are related to inhomogeneous ductile deformation that took place throughout the Beardmore–Geraldton belt. Deformation is characterized by a pervasive layer-parallel foliation and a series of shear zone systems that are associated with regional east-trending faults. A hinge fault, with maximum displacement to the south, underlies Long Lake and transects the Archean rocks.

The economic potential of the area pertains mostly to gold, which has been found associated with the east-trending regional deformation zones. The map area lies directly to the east of the Geraldton camp which produced over 3 million ounces of gold and 240 000 ounces of silver between 1934 and 1970.

PRECAMBRIAN

Archean

METAVOLCANIC ROCKS

The metavolcanic rocks underlying the map area belong to three distinct units that are traceable for the full extent of the Beardmore–Geraldton belt (Pye et al. 1965; Innes and Ayres 1970; Stott 1984a, 1984b). These are referred to informally in this report as the Northern, Central and Southern volcanic units (*see* Figure 2). A lesser metavolcanic unit, extending from Milbean Lake in the east to the old MacLeod town site in Ashmore Township (Stott 1984a), occurs within the Southern sedimentary unit. In this report, the unit will be informally referred to as the "Eldee Lake volcanic unit".

The bulk of the metavolcanic rocks underlying the map area are mafic in composition. Intermediate to felsic metavolcanic rocks are present in several places; however, because of their low abundance and limited extent, no systematic subdivision has been attempted.

Mafic Metavolcanic Rocks

NORTHERN VOLCANIC UNIT

Within the map area, the Northern volcanic unit underlies Houck and Oakes townships and constitutes approximately two thirds of the exposed metavolcanic rocks. On regional maps, the Northern volcanic unit extends from Lake Nipigon to Longlac, representing a distance of nearly 120 km (Pye et al. 1965). The widest part of the unit is in the Geraldton–Longlac area where it attains a maximum width of approximately 12 km. Within the map area, it consists of a northeasterly-striking unit of pillowed basalts which are best exposed in Oakes Township.

In Houck Township, good exposures are, for the most part, restricted to the Trans-Canada Pipelines' right-of-way and the northern arm of Kenogamisis Lake. Pillows have, in most places, been highly deformed. On flat outcrop surfaces, where selvages are clearly visible (Photo 1), pillows typically appear as lenticular shapes with length to width ratios of 2:1 to 8:1. Deformed pillows are between 1 and 3 m in length. Undeformed pillows have been observed in one outcrop beside the Crib Road in northeastern Houck Township, just north of where the road crosses Houck Creek. The largest observed pillow there is 2 m long. Pillow breccia has been recognized in a few places in the southeastern quadrant of Houck Township.

The basaltic rocks are amygdaloidal in most places; where pillow shapes are recongizable, amygdules may be abundant at the margins. Amygdule abundance and size are variable. They are most commonly of the order of a few millimetres across but amygdules up to 3 cm across have been observed in one exposure (*see* Photo 1).

Photo 1. Deformed pillows in a basaltic flow; the pillow margins contain a large number of elongated quartz amygdules. Northeastern Oakes Township.

The amygdules consist of white quartz or calcite, and less commonly of albite or chlorite.

Porphyritic rocks are rare. In northeastern Oakes Township, a narrow plagioclase-porphyritic horizon was traced for a distance of 1200 m. The phenocrysts are sparsely and unevenly distributed, and are 1 to 4 mm in size.

Pyroclastic fragmental rocks, represented by lapilli tuff, occur in central Oakes Township along the road that runs parallel to the pipeline. Mafic clasts set in a mafic tuff matrix are lens-shaped through deformation. The length of the strained lapilli is 0.5 to 10 cm, with a length to width ratio of 10:1 on the outcrop surface.

CENTRAL VOLCANIC UNIT

The Central volcanic unit continues for a distance of 180 km from Lake Nipigon to Klotz Lake (Pye et al. 1965; Stott 1984a, 1984b; Innes and Ayres 1970). Within the map area it underlies Croll and Abrey townships and the southern part of Ginoogaming First Nation. The intrusion of the Croll Lake stock separates the unit into two branches, the northern branch being poorly exposed.

Unlike the Northern volcanic unit, the Central volcanic unit consists, for the most part, of massive, non-pillowed flows. Pillows from 0.5 to 2 m in size are found on the shore of Forrester Lake, and just south on Highway 11 in southwestern Croll Township. At Forrester Lake, the pillows have selvages of uniform thickness, indicating that they are undeformed (cf. Borradaile and Poulsen 1981).

Amygdaloidal flows have been found in many places throughout the unit of the map area. Amygdules range from millimetre size to several centimetres. A large area of outcrops in northern Coltham Township displays, in places, high concentrations of large amygdules up to several centimetres across. Some amygdules are pipe-shaped and up to 10 cm long, and some represent amoeboid shaped gas cavities.

Amygdules commonly consist of quartz, calcite, chlorite, amphibole, epidote, or a combination of these. Near Mineral Lake, amygdules appear as round to elliptical black spots, up to 2 cm across, on glacier-polished outcrop surfaces. Under the microscope, these amygdules are found to consist of amphibole with a coating of quartz on the vesicle wall. When viewed in three dimensions, amygdules are commonly elongated; the elongation may be primary or tectonic.

The presence of large amygdules indicates flow tops; in some outcrops west of Mineral Lake, tops are also marked by the presence of flow top breccia.

All along the southern branch of the unit fragmental rocks representing mafic pyroclastic deposits occur. The clasts are generally of lapilli size, set in a fine-grained, mafic ash matrix. In several places, fragments are prominent due to their lighter colour, suggesting a more felsic composition (Photo 2). Porphyritic rocks with sparsely distributed, white, plagioclase phenocrysts, up to 5 mm in size, are commonly associated with the fragmental metavolcanic rocks.

The lack of pillows, the abundance of large vesicles in flows, and interflow mafic pyroclastics (lapilli tuffs) suggest emergent or subaerial mafic volcanism.

ELDEE LAKE VOLCANIC UNIT

This east-striking unit occurs within the Southern sedimentary unit and is traceable for approximately 25 km,

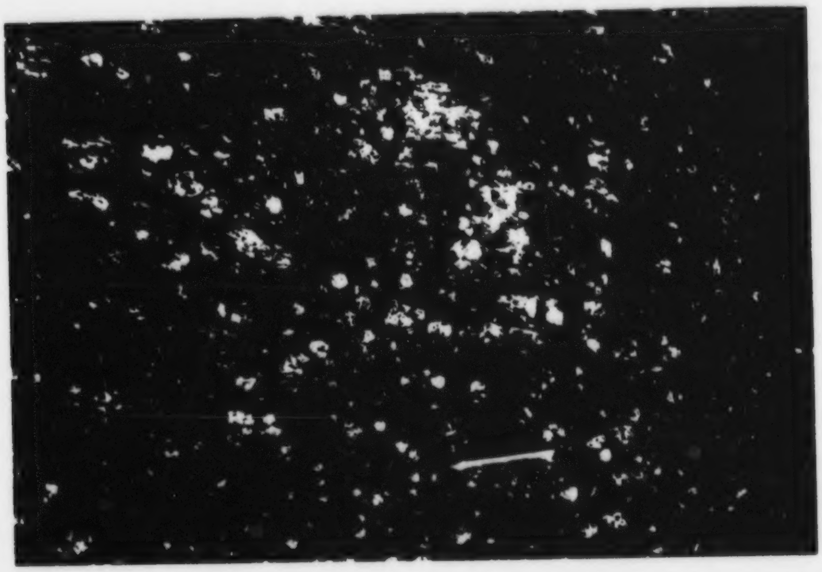


Photo 2. Lapilli tuff to tuff breccia from a small island exposure in the Northern Narrows, Long Lake. This fragmental rock consists of felsic clasts set in a chloritic, mafic matrix. The pencil used for scale is 15 cm long.

from Milbean Lake in the east to southwestern Ashmore Township, where the unit thins out. The thickest part of the unit within the map area is at Long Lake, where it is about 800 m wide. To the east of Long Lake, the rocks have largely been recrystallized to hornblende schists and primary structures were not recognized. Pervasive recrystallization, and the presence of strong penetrative fabrics, also make the distinction between mafic extrusive and intrusive rocks difficult.

South of Milbean Lake, a mafic lapilli tuff with highly deformed clasts has been observed. To the west of Long Lake the unit is poorly exposed, except on the shoreline of Long Lake. There, exposures reveal chloritic schists with few primary structures. In one place, a 2 m wide band of massive basalt displays cream-white, rounded to subhedral, plagioclase phenocrysts up to 4 cm across. Similar porphyritic horizons have been found within the Southern volcanic unit between Beardmore and Jellicoe, where they persist over considerable strike lengths (Mackasey et al. 1976; Williams 1987).

The unit is also exposed in a small cluster of outcrops in north-central Coltham Township, where the rocks have been mapped as chlorite schist; a small outcrop, on a bulldozed trail leading to the Geraldton Longlac Gold Inc. trenches, reveals chloritic structures which could be pillow selvages. In Ashmore Township, the unit has been mapped by Horwood and Pye (1955) as tuff and breccia.

SOUTHERN VOLCANIC UNIT

The Southern volcanic unit continues for a distance of some 145 km from Lake Nipigon to Pagwachuan Lake. The unit straddles the southern boundary of the map area, where it is approximately 700 m wide. On the east side of Long Lake, the unit appears as a distinctive ridge line on topographic map NTS 42 E/10. On the aeromagnetic map (ODM–GSC 1963a), the portion of the unit to the west of Long Lake stands out against the very low magnetic relief of the Quetico metasediments. Between Buckety Point and McBean Lake the unit consists of hornblende schist with a medium-grained texture. As in the Eldee Lake volcanic unit, it is difficult to clearly distinguish between extrusive and intrusive rocks because of recrystallization under amphibolite-facies conditions.

On wave-washed outcrop surfaces on the eastern shore of Long Lake, pillows and pillow breccia are clearly recognizable; pillows are very deformed with length-width ratios on the order of 10:1. Clear intrusive contacts between medium- to coarse-grained melanocratic gabbros and basalts are also exposed.

Petrology of the Mafic Metavolcanic Rocks

PETROGRAPHIC CHARACTERISTICS

The mafic metavolcanic rocks have retained their original fine-grained texture throughout the parts of the Beardmore-Geraldton belt which have undergone greenschist facies metamorphism. As a result of amphibolite-grade metamorphism, mainly to the east and north of Long Lake, most rocks have recrystallized to medium-grained textures which are mainly imparted by secondary hornblende crystals. In well foliated rocks, hornblende crystals may be particularly well developed along cleavage planes, to give the so-called feather amphibolites or *garbenschiefer* textures.

The recrystallized medium-grained mafic metavolcanic rocks cannot be easily distinguished from deformed and recrystallized gabbros. In low-grade metamorphic rocks, modal assemblages consist of actinolite, chlorite, albite, quartz, epidote-clinozoisite, carbonate and fine-grained titanite. Plagioclase phenocrysts, despite being saussuritized, may have retained their original crystal outlines.

In higher grade rocks east and north of Long Lake, the stable mineral assemblage consists of hornblende, plagioclase, quartz, epidote and titanite. The local presence of garnet and biotite indicates strong metasomatism. Hornblende schists with high biotite contents, indicating potassium metasomatism, have been found in the Central volcanic unit on the east side of Long Lake. At Buckety Point, centimetre-sized, red garnet crystals have developed along cleavage planes; in places, these garnets are very abundant. Garnet is believed to be the result of local alkali depletion in the mafic rocks.

GEOCHEMISTRY OF THE MAFIC METAVOLCANIC ROCKS

Nine samples of metavolcanic flows have been analysed for major and selected trace elements by the Geoscience Laboratories Section of the Ontario Geological Survey. The results are tabulated in Appendixes 4A through 4F. Of the nine samples (locations shown in Figure 4A–1), three are from pillowed flows from the Northern volcanic unit (samples 1A, 1D and 1J) and six are from massive flows of the Central volcanic unit (samples 1B, 1C, 1E, 1F and 1H).

Samples were chosen from least altered, fine-grained, homogeneous parts of the flows. Data plotted on the ternary AFM diagram (Irvine and Baragar 1971) shown in Figure 3a and on a Al_2O_3 – FeO + Fe_2O_3 + TiO_2 – MgO cation plot (Jensen 1976) presented in Figure 3b show compositional differences between the two metavolcanic units. The Northern volcanic unit falls within the field of iron tholeiites whereas the Central volcanic unit presents a distinct calc-alkalic affinity reflected by a lower iron content.

The analyses obtained also suggest markedly lower TiO_2, P_2O_5, Ni and Y values for the Central volcanic unit relative to the Northern volcanic unit, as well as generally higher SiO_2, Al_2O_3, Cr and lower MnO, V and Zr values. Based on the present data, values for Na_2O, K_2O, MgO, CaO, Ba, Co, Cu, Sc, Sr and Zn do not discriminate well between the two units.

All metavolcanic rocks fall well within the field of subalkalic rock compositions on a SiO_2 versus Na_2O + K_2O diagram (Figure 4) and from field evidence, no alkalic metavolcanic rocks appear to be present within the map area.

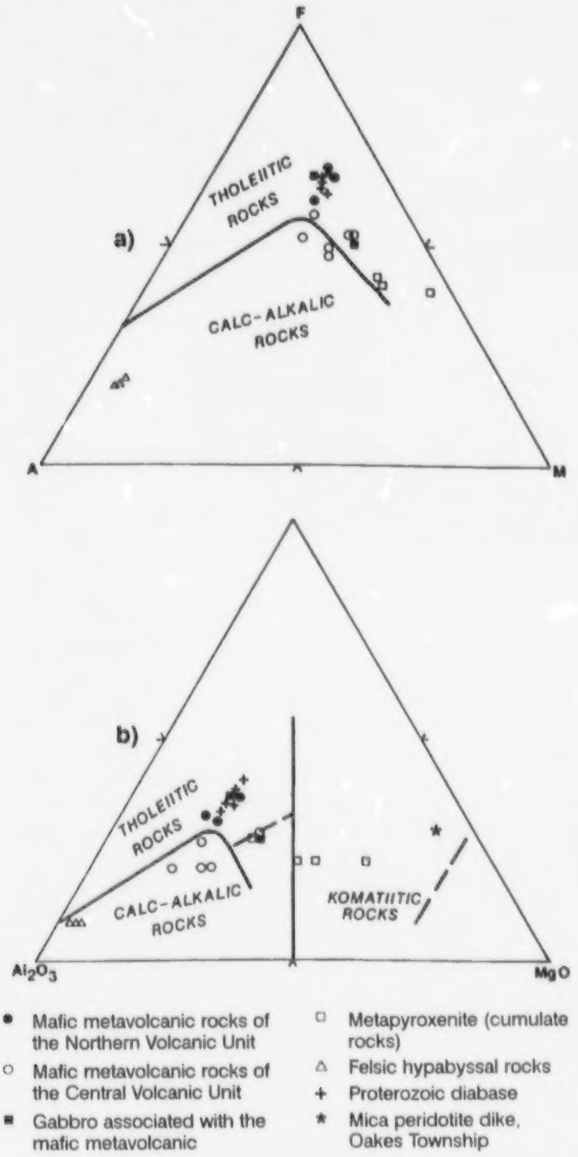


Figure 3a. Chemical classification of the various volcanic and mafic intrusive rocks from the northern Long Lake area (*after* Irvine and Baragar 1971). A = Na_2O + K_2O; F = FeO + 0.8948 Fe_2O_3; M = MgO. **3b.** Chemical classification of the various metavolcanic and intrusive rocks from the northern Long Lake area (*after* Jensen 1976). TH = tholeiitic field; CA = calc-alkalic field; KO = komatiitic field (this field being further subdivided into the fields of komatiitic basalts (left) and ultramafic komatiites (right)).

Intermediate to Felsic Metavolcanic Rocks

Fragmental metavolcanic rocks of intermediate to felsic composition occur in the Northern and Central volcanic units. These are considered to be interflow units in the mafic metavolcanic flows and they represent only a small fraction of the total metavolcanic assemblage.

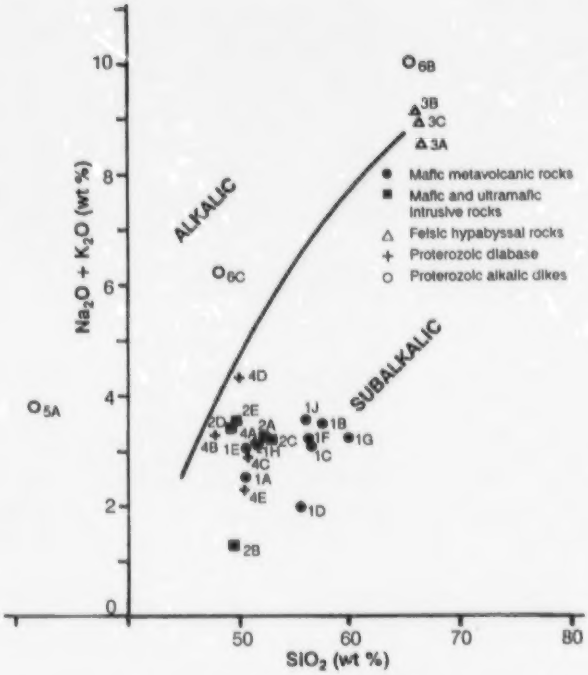


Figure 4. Chemical classification of various representative volcanic and intrusive rocks from the northern Long Lake area (*after* Irvine and Baragar 1971). Those samples which fall well within the alkalic field are from Proterozoic dikes.

Within the Southern sedimentary unit, two felsic porphyry bodies occur in southeastern Abrey Township, probably representing flows.

NORTHERN VOLCANIC UNIT

Several units of lapilli tuff and tuff breccia have been found in Oakes Township. The most prominent of these is found in central Oakes Township and extends into Houck and Daley townships. The thickest part of the unit appears to be just north of Indian Reserve No. 58, where it is approximately 700 m wide. The best exposures are found north of the Indian Reserve, where the unit consists of tuff breccia with a heterolithic clast composition (Photo 3)

The felsic clasts, which are white on the weathered surface, are set in a more mafic, amphibole-rich matrix, part of which may also represent mafic clasts in a highly deformed state. Near the township boundary, the clasts are easily recognized despite the strong deformation which produced clast length-to-width ratios on the order of 20:1. To the west of the CNR tracks, the rocks are deformed to such a state that the elongation of the clasts produces a colour banding of alternating mafic and felsic bands. To the west of Crib Road, the unit becomes narrower and the clasts diminish in size.

Further to the north, several thin units of lapilli tuff and lesser tuff breccia have been found intercalated between mafic flows. In most cases, these rocks are charac-

Photo 3. Heterolithic tuff breccia with highly deformed felsic clasts; the darker material between the felsic clasts is amphibole-rich and represents mafic matrix or deformed mafic clasts. Eastern Oakes Township.

terized by deformed, lens-shaped felsic clasts set in a more mafic matrix. In several places, felsic clasts occur within quartzofeldspathic arenite or wacke which locally displays metamorphic garnet and octahedral magnetite porphyroblasts. Primary depositional structures have been obliterated by metamorphic processes; however,in one place, in the northernmost clastic unit along the Oakes–Daley township boundary, a distinct layering is produced by thick beds of lapilli tuff, tuff breccia and mafic ash tuff. Judging from the limited thickness of these units, and their spatial association with mafic metavolcanics, they probably represent airfall deposits with associated epiclastic sediments that were deposited as interflow units.

CENTRAL VOLCANIC UNIT

The only rocks which may represent felsic volcanism in the Central volcanic unit are those containing felsic lapilli set in a mafic, ash tuff matrix. These have been found in several outcrops in Croll and Abrey townships but they do not appear to define laterally extensive units.

In the Northern Narrows of Long Lake, felsic-lapilli-bearing mafic tuff occurs over a distance of 250 m along the western lakeshore. Lapilli are typically up to 4 cm in size, fine grained, and white on the outcrop surface. In most places they are sparsely distributed, but are locally present in large concentrations (*see* Photo 2). These fragmental rocks are spatially associated with mafic, plagioclase porphyritic rocks and mafic lapilli tuff.

ELDEE LAKE VOLCANIC UNIT

A small outcrop, beside a tractor road leading to the Geraldton Longlac Gold Inc. trenches and strippings, shows a rock composed of feldspar and quartz grains up to 2 mm across. This rock is either a crystal tuff of volcanic origin or a coarse-grained arkosic arenite. It is situated on the boundary between mafic metavolcanic rocks and quartzofeldspathic sedimentary rocks to the north. The presence of quartz-feldspar porphyry clasts, up to several centimetres across, within the rock suggests a volcanic origin.

Two elliptical quartz-feldspar porphyry bodies, exposed in southeastern Abrey Township, probably represent a felsic extrusive dome. The two bodies are approximately 2.5 km and 1.2 km long and are separated by a distance of 800 m.

In the field, the porphyry appears as a light grey rock which is white on the weathered surface. It is generally fine grained and contains various amounts of plagioclase and quartz phenocrysts which are typically 1 to 3 mm across. Plagioclase phenocrysts are usually more abundant than quartz; in places phenocrysts may be scarce. The matrix is invariably quartzofeldspathic, with up to 10 percent fine-grained biotite. In most places a penetrative lineation, imparted by the elongation of minerals grains and stretched fragments, is conspicuous. The outer parts of the porphyry do not present the uniform compositions that are found in the inner part of the larger body; unequivocal, angular felsic clasts up to several centimetres across are also present.

Lapilli tuff of the same monolithologic composition as the porphyry has also been found in several places; this tuff is part of the Southern sedimentary unit described below. At the southern margin of the larger of the two porphyry bodies a faint but distinct layering, which is accentuated by a corrugated weathered surface, probably represents a tuffaceous deposit. The intimate spatial association of the porphyry and the felsic fragmental rocks suggests that the latter are derived from the porphyry. If such is the case, it suggests that the porphyry was extruded as a subaqueous volcanic dome (tholoid). Upon extrusion, the dome became covered by a carapace of autoclastic breccia, hyaloclastite and possibly pyroclastic deposits. Unfortunately, strong metamorphic fabrics and recrystallization make it difficult to genetically classify the fragmental rocks observed in the field.

METASEDIMENTARY ROCKS

The metasedimentary rocks within the map area occur in three distinct units that are informally called the Northern, Central and Southern sedimentary units in this report. Each unit will be described separately with its constituent rock types. The sedimentary rocks consist largely of epiclastic units composed of turbidites and conglomerates. Magnetite iron formation is also present in numerous places within the map area. Traditionally, iron formations are considered to be chemical sediments (Brandt et al. 1972; Gross 1973, 1980; Goodwin 1973). In the map area, the iron formation occurs as magnetite bands within turbidites, raising the question of whether these sediments represent original chemical deposits or whether they form part of the resedimented (turbidite) association. They have been classified in this study as chemical sediments.

To the west of Long Lake, where the rocks have been subjected to relatively low-grade metamorphism, many original sedimentary structures and textures are preserved despite strong tectonic deformation. Original features are best preserved in quartzofeldspathic units which were the most mechanically competent rocks during deformation. Mudstone-matrix-supported sediments that acquire a high content of phyllosilicate minerals (micas, chlorites), and metasediments (chert, ironstone) rich in microcrystalline quartz and magnetite, have invariably been highly deformed.

East of Long Lake, metamorphic recrystallization has obscured the picture even further, commonly making identification of protoliths impossible; in such instances a metamorphic connotation by using mineralogical composition (hornblende, biotite, plagioclase) was the only label applied to the rock. Since all three metasedimentary units within the map area have many common aspects, each shared rock type will be described once for all units.

NORTHERN SEDIMENTARY UNIT

The Northern sedimentary unit is a 40 km long lenticular unit which is 2.5 km wide in the centre. The unit extends from Wildgoose Lake in the west to Bickle Township in the east. Within the map area, it underlies northwestern Houck Township where it is exposed only in a few outcrops on the western shore of Alfred Lake. Exposures have also been found along the Crib Road just north of the map area (M.J. Lavigne Jr., Ministry of Northern Development and Mines, personal communication, 1987). The description of these rocks, because of their very limited exposure in the area, is based on the description of their western extension outside the map area (Beakhouse and Chevalier 1983a, 1983b; Beakhouse 1989; Kresz et al. 1990a).

Beakhouse (1989) refers to these rocks as the Hutchison Lake sediments. These are composed essentially of thinly to medium-bedded turbidites that consist of feldspathic wacke and siltstone. Pebbly wackes and minor matrix-supported conglomerate with a variety of clast lithologies, including granitic types, have been found at the southern end of Alfred Lake in McQuesten Township (Kresz et al. 1990a). Magnetite iron formation is exposed north and northeast of Hutal Lake (Beakhouse 1989). At the mouth of the Burrows River, iron formation is found as units up to 1.5 m thick that consist of alternating magnetite and wacke bands up to 2 cm thick. The strong magnetic anomaly associated with the sediments (ODM–GSC 1963b) indicates that magnetite-rich units extend eastwards to Marion Lake in Houck Township.

CENTRAL SEDIMENTARY UNIT

The Central sedimentary unit is a continuous unit for 90 km from Oakes Township in the east to Sandra Township in the west. The unit thickens gradually from west to east and appears to reach its maximum width of 2.5 km near the western margin of the map area. Within the map area, the unit is best exposed along the Dam Road and south of Octopus Lake in southeastern Houck Township. Outcrops show thickly laminated to thinly bedded wacke and siltstone with thinly to thickly bedded quartzofeldspathic arenites and wacke that commonly show good grain size gradation. In Oakes Township, where the Croll Lake stock intrudes the sedimentary rocks, garnet has developed within pelites. Pebble rows with diverse clast lithologies, including metavolcanic and granitic types, were noted in several places; these probably represent lag deposits.

A separate metasedimentary unit composed of conglomerate occurs within mafic metavolcanics of the Northern volcanic unit, north of Octopus Lake; it is distinct from the Central sedimentary unit. This unit is well exposed in a cluster of outcrops near the electric power line serving the Trans-Canada Pipeline compressor station. From these outcrops, the unit is at least 300 m wide. The lateral extent of this unit is not known, due to lack of exposure. It is highly probable, however, that it represents the eastern extension of a conglomeratic unit of an identical nature exposed near Volcan Lake, some 25 km to the west in Kirby and Fulford townships (cf. Beakhouse and Chevalier 1983a, 1983b; Beakhouse 1989). In Houck Township, the unit consists entirely of an extremely poorly sorted, polymictic, clast-supported conglomerate with pebble and cobble-size clasts (Photo 4).

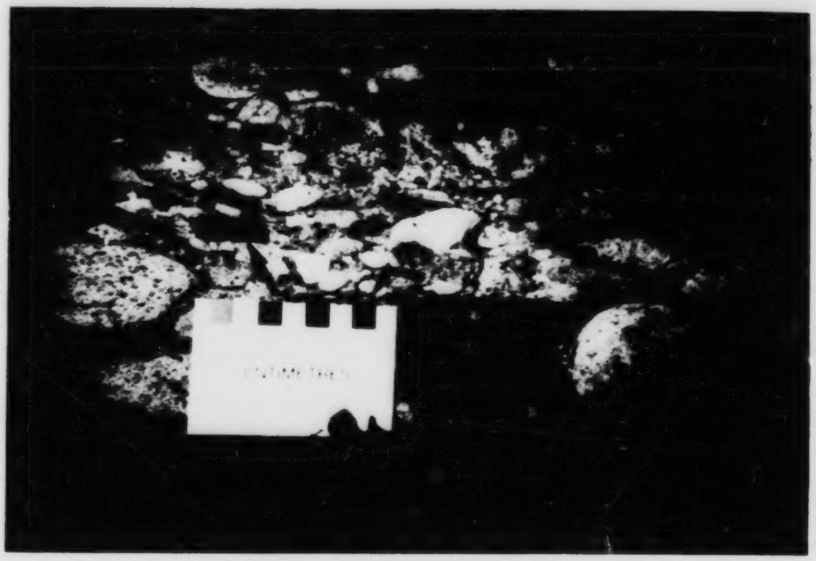


Photo 4. Poorly sorted polymictic conglomerate displaying a wide variety of clasts that include volcanic, subvolcanic and granitic types; the dark clast just above the left-hand side of the photo scale is a ferruginous (hematitic) chert. This photograph is from a narrow conglomerate unit within mafic metavolcanic rocks; field relations indicate that this conglomerate is part of a fluvial-alluvial association. Houck Township.

Metavolcanic clast types are most common. These show a wide spectrum of compositions from mafic to felsic; however, intermediate to felsic compositions are more abundant. Felsic subvolcanic rock types (feldspar porphyry) are also abundant. Other clast lithologies are: granitic rocks, chert, ironstone and vein quartz.

The degree of clast deformation is a function of composition and texture. A sequence from most to least deformed is mafic metavolcanics, felsic metavolcanics, subvolcanic porphyry, granitic rocks and vein quartz. Mafic metavolcanic clasts may have length to width ratios exceeding 15:1, whereas adjacent granitic or porphyritic pebbles seem to be undeformed.

The matrix surrounding the clasts consists of a poorly sorted, very coarse-grained, feldspathic to lithic sandstone. Beakhouse (1989) gives a very similar description of the conglomerates at Volcan Lake which occupy the same stratigraphic position. It therefore appears likely that the two conglomerate occurrences belong to a common lithologic unit.

SOUTHERN SEDIMENTARY UNIT

The Southern sedimentary unit is by far the most extensive metasedimentary unit within the Beardmore–Geraldton belt, and can be traced laterally for a distance of 180 km. The unit is thickest just west of Geraldton, where it bulges to a width of 10 km. Within the map area, it is widest in the McBean Lake area where it reaches 7 km.

Lithologically, it is most diversified north of the Eldee Lake volcanic formation, with arenite, wacke, mudstone, conglomerate and magnetite iron formation present. Figure 5 shows the variety in rock type in the Westside Bay and Birch Bay areas, where the sediments are well exposed along the shore of Long Lake. Excellent exposure over a limited area is also found at the Geraldton Longlac Gold Inc. trenches in north-central Coltham Township. Rock types present here are thinly to very thickly bedded arenites and wackes that commonly show a good grain size gradation, polymictic conglomerate and magnetite iron formation layers.

Figure 6, a simplified version of Figure 7 (back pocket), shows the various metasedimentary rock types which are exposed on the Geraldton Longlac Gold Inc. property. South of the Eldee Lake volcanic unit, the metasediments consist of a monotonous succession of quartzofeldspathic turbidites. On the west side of Long Lake, the metasediments retain numerous primary structures and textures that allow easy identification and interpretation despite strong cataclasis induced along the Barton Bay deformation zone. Much of the deformation has developed at lithologic contacts and along such mechanically incompetent rock units as: wacke, mudstone and matrix-supported conglomerate, from which abundant phyllosilicate minerals were formed upon metamorphism; magnetite iron formation; and microcrystalline quartz (chert) that are subject to recrystallization when strained.

On the east side of Long Lake, the same rock types have been subjected to a higher metamorphic grade which resulted in coarser grained textures due to recrystallization. These rocks are feldspar-amphibole schists with various amounts of biotite and almandine garnet. Metamorphic hornblende has commonly developed a feathery habit, forming rocks known as feather amphibolites. It is often difficult to identify the protoliths of these rocks because they cannot readily be distinguished from recrystallized metavolcanic rocks. In conglomeratic rocks and pebbly sediments the clasts still can be rec-

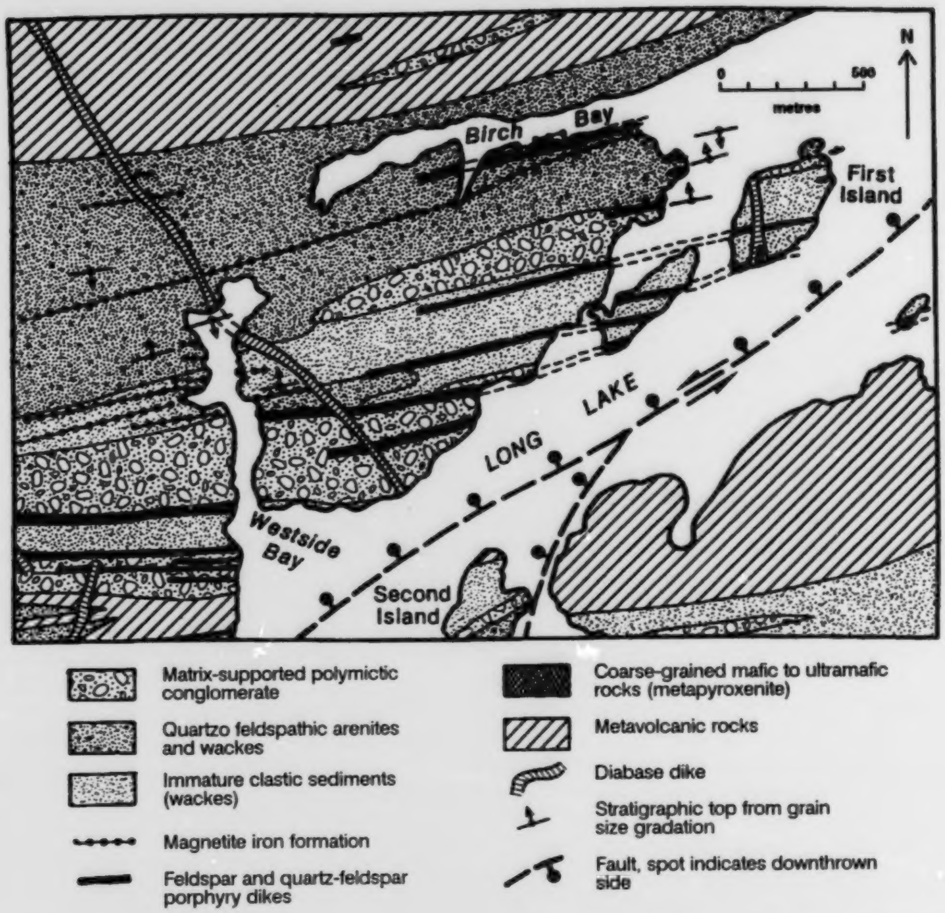

N
0
500
metres
Birch Bay
First Island
LONG LAKE
Westside Bay
Second Island
Matrix-supported polymictic conglomerate
Quartzo feldspathic arenites and wackes
Immature clastic sediments (wackes)
Magnetite iron formation
Feldspar and quartz-feldspar porphyry dikes
Coarse-grained mafic to ultramafic rocks (metapyroxenite)
Metavolcanic rocks
Diabase dike
Stratigraphic top from grain size gradation
Fault, spot indicates downthrown side

Figure 5. Simplified geology of the Birch Bay–Westside Bay area of Long Lake, showing the spatial distribution of the various metasedimentary rock types.

ognized, and porphyritic or granitic clasts, and clasts of vein quartz, may be particularly well preserved.

In contrast, quartzofeldspathic sediments with a high percentage of quartz and feldspar framework grains, such as feldspathic arenites (arkose) and wackes or quartz wackes, in many places retain their original texture due to the relative stability of quartz and plagioclase over a range of metamorphic conditions (Photo 5).

NATURE OF THE CLASTIC SEDIMENTS

Within the map area, the clastic sediments are composed of arenite, wacke, mudstone and conglomerate. All these rocks form resedimented (turbidite) facies associations (cf. Walker 1975, 1984; Ojakangas 1985).

Sandstone

Sandstones present in the area are arenites (less than 15 percent matrix), wackes (15 to 75 percent matrix) and mudstones (greater than 75 percent matrix). The classification of sandstones used in this report is shown in Appendix 3. It is readily applicable for field classification. Further subdivisions require laboratory techniques and are not practical because deformation and recrystallization have, in many places, induced textural changes.

Arenites, wackes and mudstones are described together because they are closely associated within all metasedimentary units in the map area. In many places, a complete gradation from arenite to mudstone exists across a single bed.

Turbidite sandstone beds form the bulk of all three metasedimentary units within the map area. In the field, the sandstones have a dirty, light to dark grey colour which characterizes their lack of maturity. Following field investigation and petrographic examinations, it has been possible to distinguish between 1) quartzofeldspathic sediments which are characterized by a high percentage of detrital quartz and feldspar, 2) immature sediments which carry high contents of labile grains, detrital mafic minerals and phyllosilicates, and 3) fine-grained matrix, these occur as sericite-chlorite schists and form the matrix of the conglomeratic units shown in Figure 5 and Figure 6.

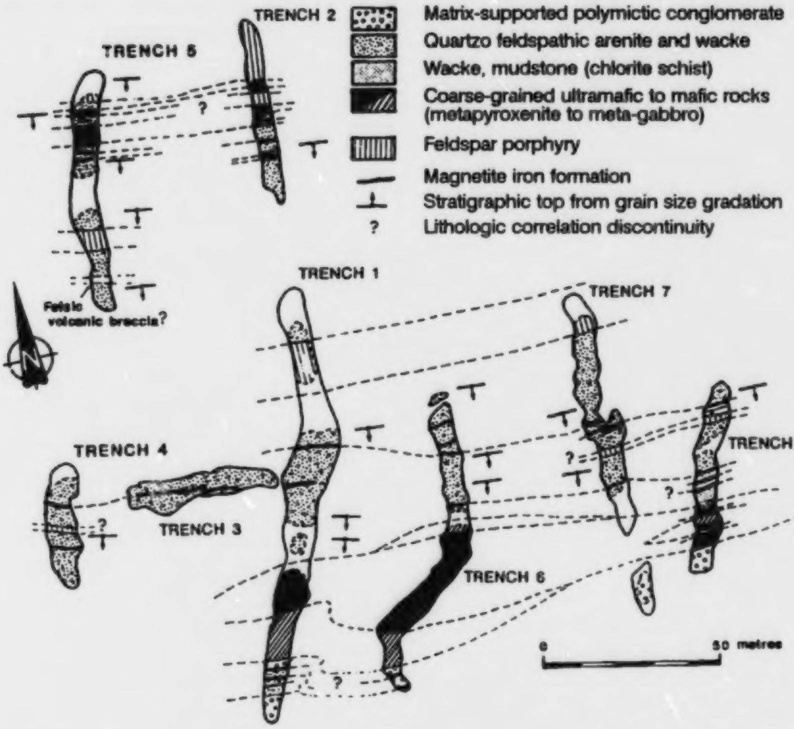

TRENCH 2
TRENCH 5
Matrix-supported polymictic conglomerate
Quartzo feldspathic arenite and wacke
Wacke, mudstone (chlorite schist)
Coarse-grained ultramafic to mafic rocks (metapyroxenite to meta-gabbro)
Feldspar porphyry
Magnetite iron formation
Stratigraphic top from grain size gradation
?
Lithologic correlation discontinuity
TRENCH 1
TRENCH 7
Felsic volcanic breccia?
N
TRENCH 4
TRENCH 3
TRENCH 8
TRENCH 6
0
50 metres

Figure 6. Simplified version of Figure 7 (back pocket) showing the spatial distribution of the various bedrock types exposed in overburden trenches; Geraldton Longlac Gold Inc. property, east trenches, northern Coltham Township.

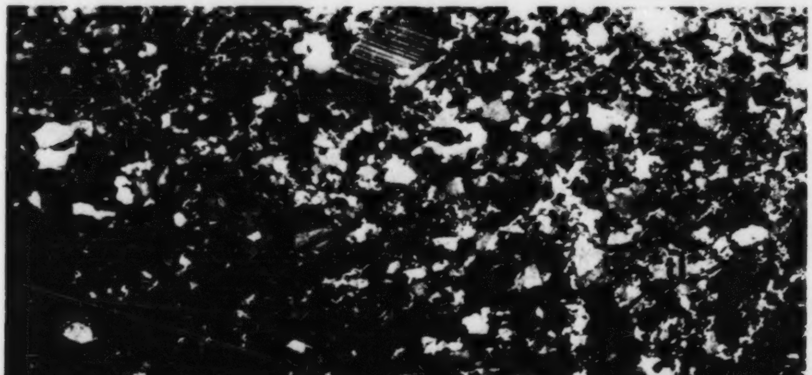


Photo 5. Photomicrograph of a feldspathic arenite. Quartz and plagioclase framework grains are undeformed although some quartz grains show recrystallization at the edges; plagioclase grains show little alteration. The matrix is sericite-rich. The titanite grain on the right-hand side is probably detrital. Trench 1, Geraldton Longlac Gold Inc. property, northern Coltham Township (*see* station GL13, Figure 7, back pocket).

Turbiditic sandstones that show good grain size gradations range from very thinly bedded to medium-bedded units (Photo 6). In the field, only Bouma's (Bouma 1962) divisions A, B and E were recognized. Most commonly observed in a single bed are the A and E divisions (*see* Photo 6). The A division consists entirely of quartzofeldspathic wacke which is massive or normally graded. In beds which are greater than 10 cm thick, the base consists, in places, of a coarse quartzofeldspathic arenite that fines upwards and grades into wacke. The B division, which is a finely laminated wacke on top of division A, is less common. Division E is rarely more than a few centimetres thick; it is commonly chloritic, with a green weathered surface, and highly fissile. Repetitive beds of constant thickness (varved wackes) are common (*see* Photo 6). Scour marks at bed interfaces were observed.

Beds of massive quartzofeldspathic arenite may be very thick (1 to 3 m). On the Geraldton Longlac Gold Inc. property (*see* Figure 6 and Figure 7 (back pocket)), thick to very thick arkose beds (Photo 7) are separated by thin beds of chloritic mudstone. These arenites are coarse- to very coarse grained, and have a high framework-grain to matrix content. Pebble lag deposits, and thin granule to pebble conglomerate bands, are present in several places.

SANDSTONES OF LOW METAMORPHIC GRADE

The framework constituents in the quartzofeldspathic sandstones are plagioclase and quartz (*see* Photo 5). Other original framework grains must be considered as part of the matrix because of their more labile nature. Minor detrital components are magnetite, titanite and zircon. In low-grade rocks west of Long Lake, the matrix to the framework grains consists of fine-grained quartz and albite, sericite, and chlorite, with lesser epidote and carbonate.

Framework-grain to matrix ratio is highly variable in all three metasedimentary units. Following Young's (1967) classification scheme (*see* Appendix 3), sandstones with a matrix estimate of over 15 percent have been called wackes. Feldspathic arenites with low matrix contents of 10 to 15 percent are well exposed in northern Coltham Township at the Geraldton Longlac Gold Inc. trenches. There, the content of framework quartz grains is approximately one third that of framework feldspar (*see* Photo 5). In the least deformed wackes and arenites, the detrital quartz and feldspar grains are typically very angular to subangular; however, a few well-rounded grains are seen.

Very immature sedimentary rocks occur mostly as chlorite and sericite schists with a pronounced fissility.

ROCKS OF LOW TO MEDIUM METAMORPHIC GRADE

Those sedimentary rocks that occur on the east side of Long Lake, and those that are within the metamorphic contact aureole of the Croll Lake stock, have been subjected to higher metamorphic grades than the rocks west of Long Lake. Metamorphic indicator minerals noted are biotite, almandine garnet, hornblende and andalusite. In quartzofeldspathic sandstones, grain sizes have not been significantly modified by metamorphism. In rocks of low strain, the original shapes of the quartz and feldspar grains are preserved, owing to the stability of quartz and low-calcium plagioclase metamorphic grade. A strong planar fabric imparted by micas, and in more highly strained rocks by elongated quartz and feldspar grains, has been observed in almost all exposures.

Microscopic observations indicate that in most cases, strained minerals have recrystallized into a granular texture. Locally, however, larger, non-recrystallized detrital fragments do stand out amongst the other grains. South of the Eldee Lake volcanic unit, recrystallization of the sandstones has resulted in quartz-plagioclase-biotite schists which display a strong layering in places. In the Quetico metasedimentary terrane proper, south of the Southern volcanic unit, these schists are coarse-grained because of the growth of large mica grains. The original aphanitic matrix has recrystallized into larger quartz, feldspar, biotite, muscovite and hornblende crystals. Garnet and andalusite porphyroblasts have formed in the pelitic components. Garnets may be used in the field as stratigraphic top indicators as they are commonly concentrated in the pelitic, mudstone-rich tops in graded beds.

Andalusite porphyroblasts are present in muscovite schists near Buckety Point, in the Northern Narrows opposite Jackfish Bay at Long Lake, and in one occurrence halfway between Skinner Lake and the Making Ground River. Andalusite occurs as white nodular grains up to 1 cm across, in bands 1 to 2 m thick, and may constitute up to 15 percent of the rock. In thin section, the porphyroblasts show numerous inclusions of quartz and feldspar that may define a spiral pattern indicating rotation during growth. At Buckety Point, the andalusite is altered to muscovite; here, garnets 0.5 mm across are found.

Sediments with lower quartzofeldspathic content have been metamorphosed to hornblende-biotite schists in the Southern sedimentary unit. Hornblende has commonly grown as centimetre-long sheaf-like crystals in a fine-grained quartz-feldspar-biotite matrix (feather amphibolite). Garnet may also be present. The hornblende schists are, in many places, also found associated with quartzofeldspathic schists that are more readily identified as a metasediment in the field. Amphibole schists with a high hornblende content are not easily distinguished from metamorphosed mafic igneous rocks.

Conglomerate

Within the map area, conglomerate forms discontinuous units intercalated with sandstones in the Southern sedimentary unit. In the Northern and Central sedimentary units, only pebble rows representing lag deposits have been found within the wackes. In southeastern Houck Township, a clast-supported conglomerate unit

Photo 6. Thin- to medium-bedded turbiditic sandstones showing normal grading of sand-sized particles; the darker bands are mudstone-rich tops. Note the low-angle discordance due to thrusting. The stratigraphic facing direction is shown by the arrow; the large divisions of the bar scale represent 5 cm. Trench 1, Geraldton Longlac Gold Inc. property, east trenches, northern Coltham Township (*see* Figure 7, back pocket).

Photo 7. Thick to very thickly bedded coarse-grained feldspathic arenites. The beds are ungraded and are separated by thin mudstone to wacke bands. They show a progressive thinning from right to left in the photograph and are overlain by the graded sandstone shown on Photo 10. Stratigraphic facing is to the left. Trench 1, Geraldton Longlac Gold Inc. property, east trenches, northern Coltham Township, (*see* station GL12 Figure 7, back pocket).

occurs within the metavolcanic rocks of the Northern volcanic unit; although separate from the Central sedimentary unit, it has been described above, in that section.

In the Southern sedimentary unit, the best conglomerate exposures occur along the western and eastern shoreline of Long Lake. Coarse clastic rocks are also present in north-central Coltham Township where they occur in a highly strained state, and in various locations east of Long Lake where metamorphic recrystallization has obscured many sedimentological features. All coarse clastic metasedimentary rocks found throughout the Southern metasedimentary unit have more or less the same characteristics. Therefore, only one represen-

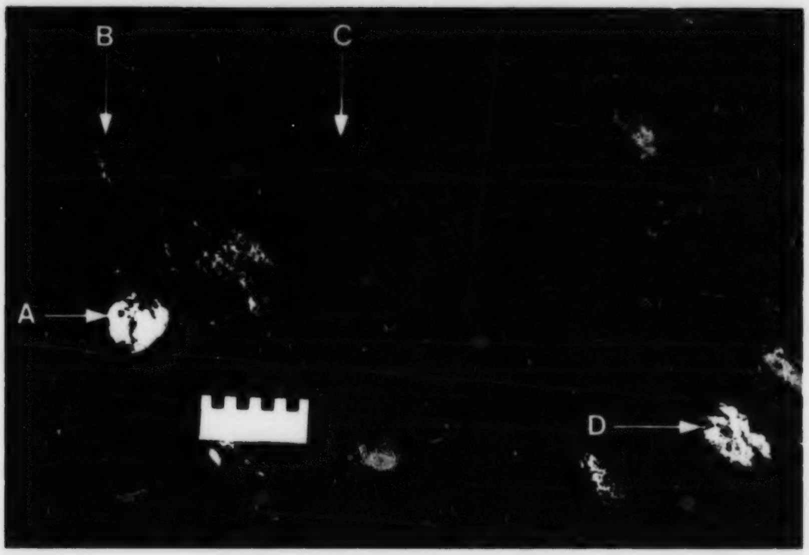


Photo 8. Resedimented polymictic conglomerate; the clasts include metavolcanic rocks (A—highly elongated), subvolcanic intrusive rocks (B—elliptical, grey coloured clasts), granitic rocks (C—elliptical, light coloured), and vein quartz (D—well-rounded). This conglomerate is similar in composition to the conglomerate shown in Photo 4; however, its close spatial association with graded arenites and wackes suggest that it is part of the turbidite association. Westside Bay, northeastern Coltham Township.

tative occurrence, namely the extensive shoreline exposures between Westside Bay and First Island are described here. Within that area (*see* Figure 5), the conglomerates are polymictic with a wide variety of clasts (Photo 8). In order of abundance, these are: metavolcanic rocks of various compositions, felsic subvolcanic rocks, granitic rocks and vein quartz. With respect to clast composition, these conglomerates are very similar to the conglomerates found in southeastern Houck Township. The least deformed rocks reveal a matrix-supported nature. This character, however, cannot be ascertained for all conglomerates because of the extreme state of deformation in some places.

In deformed rocks, mechanically resistant clasts are nested in sericite schist for which it is not always possible to separate true matrix from deformed metavolcanic material. Clasts range from pebble to cobble sized, but locally, boulder-sized clasts have been observed. Field relationships indicate that the conglomerates are not laterally extensive units (*see* Figure 5), forming what are probably lensoid beds within the turbiditic sandstones. The largest unit shown in Figure 5 is not more than 400 m wide.

The authors believe that the conglomerates have been deposited along channels on a submarine fan (cf. Walker 1975, 1984) and form an integral part of the resedimented marine turbidite association (Figure 8).

Iron Formation

The term "iron formation", which is a generic term applied to a variety of banded ferruginous-cherty rocks of sedimentary origin (Brandt et al. 1972; Goodwin 1973), is used in this report to designate magnetite-rich layers of various thickness that are associated with the clastic sediments. Although the magnetite layers are commonly rhythmically interlayered with fine-grained clastic sediments, the term "banded iron formation", which has been sometimes used in the general Beardmore–Geraldton area (Fralick and Barrett 1983; Macdonald 1984; Williams 1986, 1987), is here avoided, as it is considered better reserved for interbedded ferrugi-

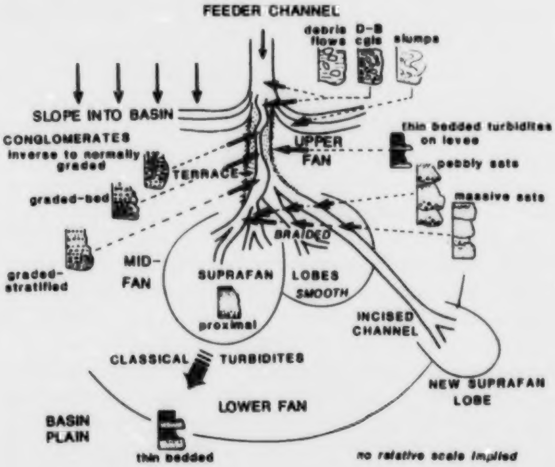

FEEDER CHANNEL
debris flows
D-B cgls
slumps
SLOPE INTO BASIN
CONGLOMERATES
inverse to normally graded
TERRACE
graded-bed
graded-stratified
UPPER FAN
thin bedded turbidites on levee
pebbly ssts
massive ssts
BRAIDED
MID-FAN
SUPRAFAN
LOBES
SMOOTH
proximal
INCISED CHANNEL
CLASSICAL TURBIDITES
NEW SUPRAFAN LOBE
LOWER FAN
BASIN PLAIN
thin bedded
no relative scale implied

Figure 8. Submarine fan model proposed by Walker (1978). Many of the various sedimentary facies shown on the diagram are found within the Southern sedimentary unit; *after* Walker (1984). Used with permission of the Geological Association of Canada.

nous-chert deposits believed to be chemical or biochemical precipitates (Brandt et al. 1972; Gross 1973, 1980; Goodwin 1962, 1973).

Within the map area, chert bands of any scale have not been found associated with the iron formations. Barrett and Fralick (1985) have also noted the lack of chert throughout the entire Beardmore–Geraldton belt, aside from red jasper bands that occur in a few places, such as at the Hardrock Mine in Ashmore Township. In iron formation with multiple magnetite layers (Photo 9), the non-ferruginous interbeds are siltstone and mudstone.

The lack of chert in Beardmore–Geraldton belt iron formation distinguishes it from the well documented Algoma-type iron formation (Goodwin 1962, 1973).

GENERAL DESCRIPTIONS OF IRON FORMATION

Magnetite iron formations found within the map area differ little from other known occurrences in the Beardmore–Geraldton belt. They are found in the Northern and Southern sedimentary units, where they produce a very strong magnetic signature on aeromagnetic maps (ODM–GSC 1963a, 1963b, 1965). The associated magnetic anomalies are laterally continuous over a considerable distance and therefore may serve as stratigraphic markers.

Magnetite iron formation occurs rhythmically interlayered with fine-grained clastic bands on a scale of one millimetre to a few centimetres (*see* Photo 9) or as single magnetite units of uneven thickness along strike with one another, within wacke or arenite (Photo 10). Laminated units with alternating parallel magnetite and clastic bands, such as shown in Photo 9, locally resemble varved sediments. Such units may consist of several tens of magnetite-clastic laminae pairs. Thick magnetite units also have an internal banded structure that is commonly folded. Magnetite bands are also found as thin, wispy bands in coarse-grained arenites.

PETROGRAPHY OF IRON FORMATION

In the field, the magnetite layers appear to consist of dark grey to black fine-grained magnetite, which is commonly difficult to distinguish from associated dark-coloured mudstones. A banded structure is always associated with them, even in the more massive-looking types. Under the microscope, the layers are made up of granular magnetite and quartz grains that are on the order of 0.05 to 0.1 mm across. In the most massive-looking iron formation, magnetite makes up approximately 50 percent of the rock, the remainder is quartz. The same massive-looking magnetite layers possess a finely banded structure that is produced by the alternation of magnetite-rich and quartz-rich laminae. The quartz-rich laminae may also contain various amounts of chlorite (or hornblende), carbonate and epidote. These laminae may represent recrystallized cherty microbands.

East of Long Lake, some iron formation contains conspicuous amphibole. At Milbean Lake, an iron formation exposure displays hornblende prisms up to 2 cm long, near quartz bands; these commonly form radiating clusters. In places, cubes of pyrite up to several millimetres in size are found in the iron formations. In north-central Coltham Township, pyrite has been found to replace magnetite near quartz veins (Photo 11). Gold mineralization is associated with such replacement.

ORIGIN OF THE IRON FORMATION

Archean iron formations have been studied in the past, but much of the literature on the subject alludes to the so-called "banded iron formation" (BIF) in which chert bands are associated with ferruginous minerals, such as in the well-documented Michipicoten area (Goodwin 1962). The general consensus is that these iron formations represent some form of chemical or biochemical deposits.

The "magnetite only" iron formations are not unique to the Beardmore–Geraldton belt and have been described in many other places (Barrett and Fralick 1985). In the Beardmore–Geraldton belt, the turbidite-hosted iron formations have been studied by Barrett and Fralick (1989) who suggested that they were deposited in a submarine fan environment; these authors also favour a chemical origin for the magnetite, through volcanic exhalative processes.

From tectonic features observed in iron formations (Photo 10, Photo 11, Photo 12) it is believed that they are in a highly deformed state and any sedimentological interpretation must be done with great caution. Williams (1987) has shown that finely layered iron formation in the Beardmore area represents a highly transposed early layering, presumably original bedding. Iron formations are generally believed to form in the deep parts of a sedimentary basin with a slow rate of sedimentation. In northern Coltham Township, the iron formations shown on Figure 6 and Figure 7 (back pocket) are hosted in coarse, massive feldspathic arenites which are more characteristic of rapid sedimentation rates near submarine fan channels (*see* Figure 8). It is also possible that the iron formations have been, in part, tectonically imbricated into the coarse sandstones according to features such as those shown in Photo 13. The iron formations themselves, although probably of chemical origin, may also be resedimented deposits.

Chert

Chert is rare within the map area. It has been found in only two places; it occurs as white saccharoidal quartz horizons intercalated between clastic sediments or metavolcanic rocks. The present granular texture is recrystallized from the original microcrystalline quartz. One chert occurrence is situated within the Southern sedimentary unit, 600 m south of the Abrey Township line where it is found in an outcrop cluster 20 m across, marked by a rusty weathered surface.

Narrow bands of disseminated coarse magnetite grains are found within the otherwise monomineralic

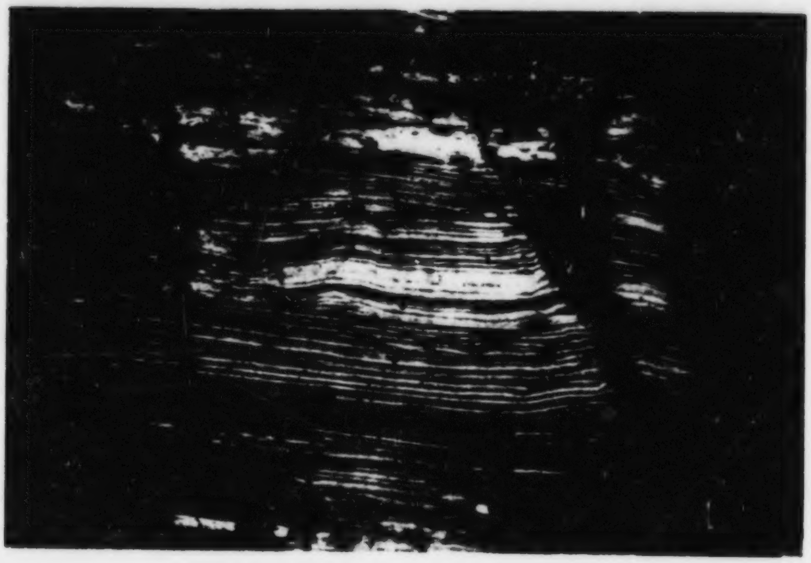


Photo 9. Thin, alternating layers of magnetite iron formation and siltstone. Westside Bay, northeastern Coltham Township.

Photo 10. Magnetite iron formation unit associated with thick coarse-grained arenite beds (light coloured) and wacke (grey coloured bands beside hammer). A small-pebble conglomerate band is seen below the iron formation. Trench 1, Geraldton Longlac Gold Inc. property, east trenches, northern Coltham Township (*see* station GL13, Figure 7, back pocket).

rock. This rock probably represents a siliceous chemical precipate marking a time interval between periods of clastic sedimentation. The magnetite-bearing layers represent recrystallized ferruginous beds.

The second exposure of chert, 1 m across, is found on the Oakes Daley township line in the Northern volcanic unit. The rock consists of fine-grained sugary quartz with abundant pyrrhotite stringers carrying anomalous gold values. The extent of the chert unit is not yet known, but it probably represents a siliceous chemical horizon between metavolcanic deposits, in which iron was deposited as a sulphide.

Chert has not been found associated with the more common magnetite iron formation described above.

Regional Sedimentology

The only comprehensive sedimentological study within the Beardmore–Geraldton belt, was carried out in the

Photo 11. Magnetite iron formation (below hammer) in metapyroxenite (dark coloured, on each side of hammer); the lighter rock is chlorite schist after sheared pyroxenite. Birch Bay, Long Lake.

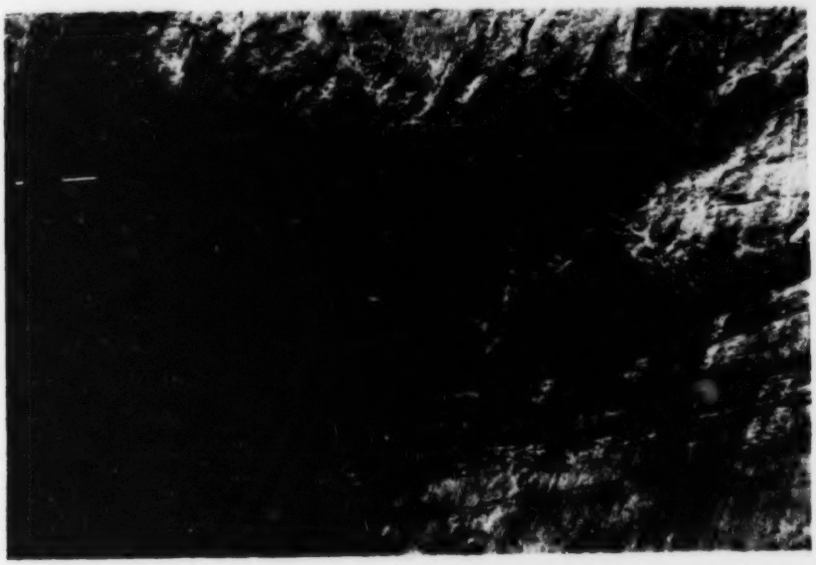


Photo 12. Abrupt termination of a magnetite iron formation unit in coarse-grained, massive feldspathic arenite. The iron formation shows an internal laminated layering that is asymmetrically folded. The sandstone tongue in the centre of the photograph appears to have produced the delamination of the main iron formation unit during shearing; the structure resulted from dextral shear. The large divisions on the bar scale represent 5 cm. Trench 3, Geraldton Longlac Gold Inc. property, northern Coltham township (*see* Figure 7, back pocket).

western part of the belt by Devaney (1987), who has demonstrated the presence of both marine and non-marine metasedimentary associations. The non-marine facies is represented by coarse polymictic conglomerates and interbedded sandstones that were interpreted to have been deposited by braided rivers. The marine association is mainly represented by turbidite deposits.

Within the map area, the bulk of the metasediments are turbidite deposits that are composed of well-bedded massive and graded sandstones, matrix-supported resedimented conglomerates and iron formation. These are interpreted to have been deposited in a submarine fan, following the model adopted by Walker (1978) and reproduced in Figure 8. Conglomerates, such as those found in the Southern sedimentary unit, do not necessarily represent a "proximal" clastic facies sometimes claimed to delineate basin margins (cf. Goodwin 1977); Walker (1978) points out that deep-water gravels have been found from several tens to over 100 km from modern shelf edges.

The conglomerates exposed in southeastern Houck Township appear to be very similar to the conglomerate at Volcan Lake in Kirby and Fulford townships (Beakhouse 1989), which in turn are similar to those described in Devaney's (1987) "Northern Metasedimentary Belt". It seems very probable that these conglomerates represent the same lithostratigraphic unit of subaerially deposited conglomerates, because of their identical position within the Beardmore–Geraldton volcano-sedimentary assemblage. Devaney and Williams (1989), by using field observations and point counts, have indicated that the fluvial and resedimented conglomerates have the same provenance. The similarity in clast composition of conglomerates and pebbly sandstones within the present map area may be used in extending this relationship throughout most of the Beardmore–Geraldton Belt. The identical clast composition in the various conglomerates may also provide good evidence to establish the lithostratigraphic and chronostratographic equivalence for the marine and non-marine association and hence the relationships between the Northern, Central and Southern sedimentary units. These implications can only be examined in the light of structural considerations as outlined by Devaney and Williams (1989).

In the general Beardmore–Jellicoe area, it has been noted that the sediments become coarser to the north (Bruce 1935; Laird 1936; Ayres 1969; Mackasey 1972; Devaney 1987), implying that the source was in the north. This trend has not been observed in the Geraldton–Longlac area.

INTRUSIVE ROCKS

Gabbro

Gabbro intrusions are confined to the mafic metavolcanic units, thereby suggesting that they are intrusive equivalents of these rocks. Only two coarse-grained samples from the Central volcanic unit (*see* Appendix 4C) were analyzed (samples 2A and 2C). Geochemically, they are subalkalic and therefore, have been included on the ternary plots in Figure 3.

The gabbros are typically medium- to coarse-grained, mesocratic to melanocratic, equigranular rocks. Contacts with the metavolcanic units have been observed in only a few places. In the east end of the map area, on land of the Ginoogaming First Nation, a 1.5 m wide gabbro dike shows a gradual textural fining towards the contacts.

Plagioclase porphyritic gabbro has been found, but it is not common. On the south shore of Noel Lake, bluish quartz eyes have been seen in a melanocratic gabbro. Compositional layering has not been observed in gabbro bodies within the metavolcanic host rocks, but it has been observed in gabbroic rocks in the Southern sedimentary unit.

The gabbro occurs as tabular sills and dikes such as at Noel Lake in Oakes Township, or as lenticular to elongated irregular bodies which may be several kilometres long. The trend of all intrusive bodies is parallel to the general layering of the host metavolcanic rocks.

Mineralogical compositions are represented by secondary assemblages after the main primary phases, plagioclase and pyroxene. In rocks of lower greenschist-facies, primary plagioclase has degraded to epidote-clinozoisite, calcite, albite and quartz, and pyroxene has degraded to actinolite and chlorite. Oxide minerals are represented by magnetite and ilmenite intergrowth in which ilmenite has degraded to fine-grained titanite. The original texture has been preserved in many places; however, original crystal outlines have been preserved only in the least deformed rocks.

In upper greenschist- to lower amphibolite-facies rocks, the metamorphic mineral assemblage consists of low-calcium plagioclase, green hornblende, quartz, epidote, magnetite, titanite and, in places, biotite. Despite the higher degree of recrystallization, the original overall texture has commonly been preserved. Highly foliated and metamorphosed gabbro and basalt are difficult to distinguish.

Cumulate-textured Mafic and Ultramafic Rocks

Peculiar coarse-grained mafic igneous rocks occur within the Southern sedimentary unit. These have been found 1) at Birch Bay in the northwestern corner of Abrey Township, 2) in north-central Coltham Township, and 3) south of Skinner Lake in southeastern Abrey Township.

At Birch Bay of Long Lake, a massive, dark green, coarse-grained equigranular rock occurs over an approximate width of 40 m along the southern shore of the bay for a distance of 550 m. The rock consists of tightly packed, equant mafic crystals up to 8 mm across; fine-grained epidote fills the interstices.

Under the microscope, the mafic grains consist of fibrous actinolite (uralite) after clinopyroxene. The interstices between the altered pyroxene crystals contain fine-grained epidote, albite and calcite which represent degraded calcic plagioclase. From visual estimates, the rock was originally made up of approximately 90 percent clinopyroxene; therefore it has been called a pyroxenite. The margins of the body are highly sheared and are now chlorite schist. This body of rock is enclosed in turbiditic sandstones containing bands of magnetite iron formation.

At the mouth of Birch Bay, iron formation occurs within the sheared pyroxenite (*see* Photo 11), undoubtedly a result of ductile deformation. In the same location, two, parallel, 1 m wide layers of medium-grained diorite are present between sheared and massive pyroxenite. The diorite is composed of relatively fresh plagio-

Photo 13. Graded layering in cumulate-textured pyroxene rock. The grading is characterized by a fining of pyroxene crystals which is accompanied by an increase in plagioclase content toward the top of the photo in each layer. Pencil used for scale is 17 cm long. Trench No.8, Geraldton Longlac Gold Inc. property, northern Coltham Township (*see* Figure 7, back pocket).

clase, biotite, chlorite, aggregates of white mica, and magnetite. On the weathered surface, numerous elliptical, epidote-rich pods have been observed. The relationship between the diorite and the pyroxenite is not clear.

Similar coarse-grained ultramafic to mafic rocks are found in recent exploration trenches in central Coltham Township. A pyroxenite body, similar to the one at Birch Bay, is exposed in trenches 1, 6 and 8 shown on Figure 6 and Figure 7 (back pocket); and in other trenches 0.8 km to the west, shown in Figure 19. The pyroxenite body exposed in trench 6 is 20 m wide but is much narrower in trenches 1 and 8 on either side. In trench 8, the pyroxenite, which elsewhere is massive and structureless, is repetitively layered. Each layer is about 15 cm thick and shows a grain size gradation of the pyroxenes (Photo 13); the upper part of each layer is plagioclase-rich. The layering is not extensive and it is therefore believed to represent a gravity flow of a crystal mush. It is worth noting that the gradation direction is opposite to the gradation within sandstone beds. Normal mesocratic gabbro occurs adjacent to the pyroxenite.

In trenches 2 and 5 (*see* Figure 7 (back pocket)), two units a few metres wide are found within arkosic arenite and feldspar porphyry (*see* Figure 6). The rock consists of rounded pyroxene crystals, some of which present a euhedral outline, in a fine-grained plagioclase-rich matrix. The original minerals have all been degraded to a secondary metamorphic assemblage. A distinct layering, defined by pyroxene and plagioclase-rich bands and graded pyroxene-rich layers, is present (Photo 14).

The peculiar features associated with bodies of such limited size would be expected in larger, differentiated mafic intrusions rather than in small, metre-scale units. The fact that they are found within a major fault zone, the Barton Bay Deformation Zone, suggests that these mafic and ultramafic rocks represent tectonized slivers derived from a much larger unexposed mafic intrusion. South of Skinner Lake, two exposures 400 m apart show a pyroxene-rich rock similar to the one found at Birch Bay; in both exposures the mafic rock is hosted by turbiditic sandstones and magnetite iron formation.

Three samples of coarse-grained pyroxenite (samples 2B, 2D and 2E) were submitted for whole rock analysis (*see* Appendix 4C). They are magnesium-rich and characterized by higher MgO, K_2O, Co, Cr, Ni and Sr contents compared to gabbro hosted by the metavolcanic units (samples 2A and 2C, Appendix 4C). The analysed samples have very consistent SiO_2, total FeO and TiO_2 as well as Co, V, Zn and Zr concentrations. However, they show variations in Al_2O_3, CaO and MgO, Cr and Ni contents, which supports a cumulate origin for these rocks. All three samples are highly olivine normative.

Felsic Subvolcanic Porphyry Intrusions

Felsic porphyries are found throughout the map area and occur as dikes or sills up to several metres wide. Their present orientation is parallel to the general trend of the major rock units and to their parallel schistosities. This suggests that at least some of these intrusions may have been transposed; especially those which show a considerable amounts of shearing at the margins.

The porphyries are of two types: feldspar porphyry and quartz-feldspar porphyry. There is no particular association of porphyries and supracrustal rock types nor are there identifiable swarms; except at Birch Bay and Westside Bay of Long Lake where a series of distinct, plagioclase (albite) porphyritic dikes intrude the sediments of the Southern sedimentary unit. Two quartz-

Photo 14. Layered cumulate-textured mafic body hosted by coarse-grained feldspathic arenite. The layering is produced by pyroxene (dark coloured) and plagioclase-rich (light coloured) bands that probably formed by cumulate processes. The contacts with the sandstone (shown by the arrows) are sheared. Trench No.5, Geraldton Longlac Gold Inc. property, station GL30 (*see* Figure 7, back pocket); position 14m on Figure 12.

feldspar porphyry bodies in southeastern Abrey Township are believed to be extrusive rather than intrusive.

FELDSPAR PORPHYRY

Feldspar porphyry occurs as tabular intrusions up to several metres wide. It typically consists of white plagioclase phenocrysts in an aphanitic quartzofeldspathic matrix. Biotite may also be present as small phenocrysts and as a matrix constituent.

Between Birch Bay and Westside Bay of Long Lake (*see* Figure 5), a series of parallel dikes occur within the turbiditic sediments. The dikes consist of densely packed white albite phenocrysts which are up to 8 mm across, in a grey aphanitic quartzofeldspathic matrix. The porphyry is generally grey, but several dikes are pink due to alteration. Some of the dikes are highly sheared along their contacts.

Three samples of albite porphyry have been submitted for whole rock analysis (samples 3A, 3B and 3C). The analytical values are shown in Appendix 4D. All three dikes show similar compositions and are classified as dacites. The porphyries contain high sodium values and are poor in calcium and potassium.

QUARTZ-FELDSPAR PORPHYRY

Porphyry dikes which carry plagioclase and quartz phenocrysts are common throughout the map area. They occur in greater abundance in Abrey Township, east of Long Lake. The dikes are generally oriented parallel to the trend of the major supracrustal units and appear to be, at the most, only a few metres thick. Some dikes found in the Mineral Lake area may be related to the Croll Lake stock.

Granitic Rocks

THERESA STOCK

A small, granitic intrusion, here informally named the Theresa stock, outcrops on the eastern boundary of Abrey Township. In Abrey Township, the Theresa Stock is composed largely of a light grey, massive, equigranular, medium-grained granitic rock consisting of plagioclase, quartz, and up to 20 percent amphibole. Modal analyses performed on five samples indicate that the stock is of tonalitic composition within the map area (Figure 9). Accessory minerals are magnetite, titanite, apatite, biotite and epidote. Examination of thin sections reveals that the plagioclase is saussuritized and that the amphibole occurs as clusters of secondary metamorphic hornblende crystals. This implies that the intrusion has been metamorphosed and may therefore be pretectonic.

Large outcrops of quartz porphyry occur within the northern part of the Theresa stock and are probably related to it. Fine-grained mafic dikes and feldspar porphyry dikes also cut the granitic rocks. Quartz and quartz-tourmaline veins occur in the southern half of the stock in Abrey Township. Gold mineralization at the Theresa Mine, situated outside the map area, is found within quartz veins occurring at the contact of the intrusion (Fairbairn 1938).

CROLL LAKE STOCK

The Croll Lake stock is an elliptical intrusion, approximately 150 km^2 in size, extending diagonally in a south-

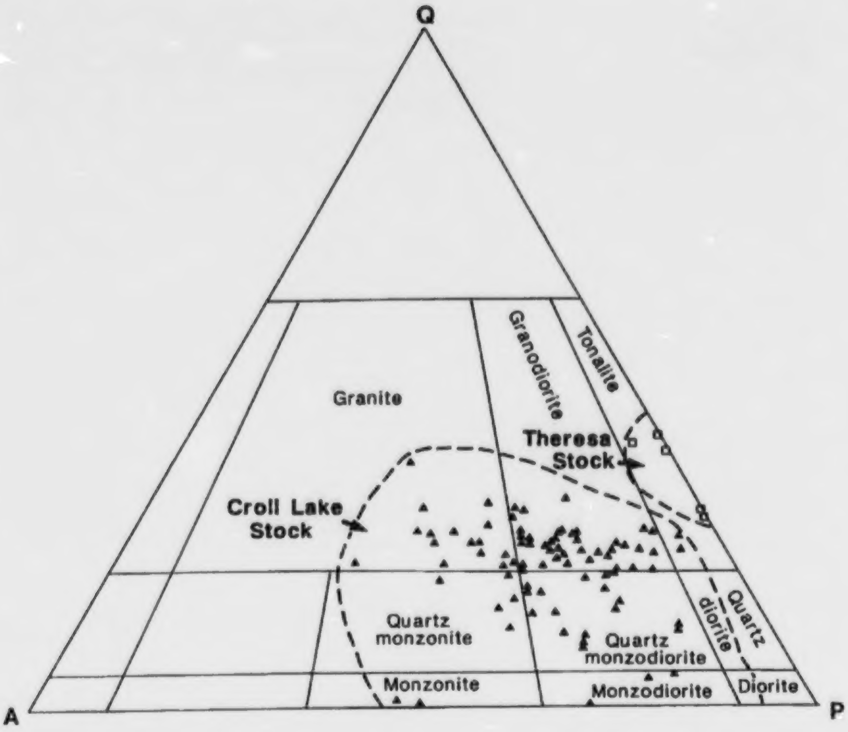


Figure 9. Quartz-potassium feldspar-plagioclase (Q-A-P) ternary plot (*after* Streckeisen 1976) showing the position of various modal compositions for the Croll Lake stock and the Theresa stock. Each modal determination is based on a 300-point count.

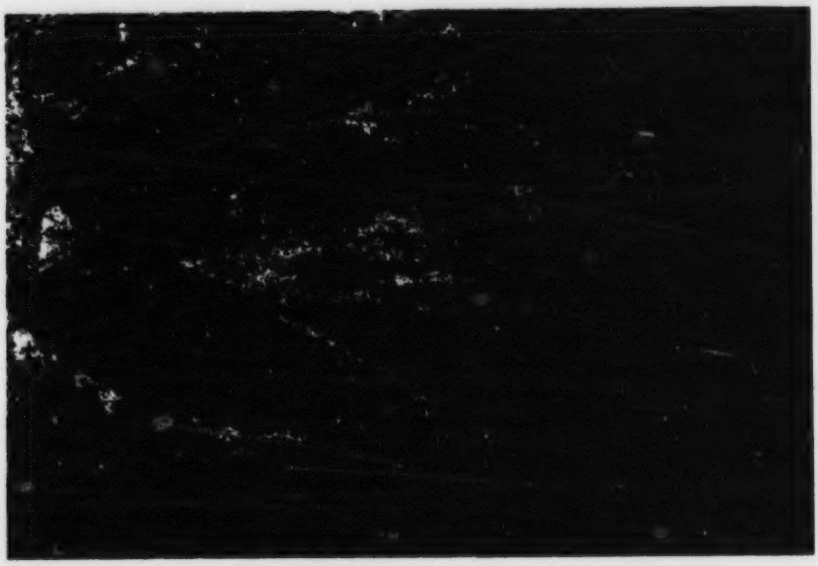


Photo 15. Mafic inclusions in hornblende granodiorite; these elliptical inclusions are found throughout the Croll Lake stock and are uniformly rich in hornblende. Oakes Township.

westerly direction across the map area. It consists of medium- to coarse-grained felsic granitic rocks which show compositional variation throughout the stock. Modal analyses on 96 slabbed samples have been performed to determine the composition of the Croll Lake stock as well as to determine internal variation. The Streckeisen (1976) scheme for classification of granitic rocks has been adopted (*see* Figure 9).

The southern part of the stock consists mainly of granodiorite whereas the northern part ranges from granite to granodiorite with some monzonite, quartz monzonite and quartz monzodiorite. The more felsic compositions are found along the northern margin of the stock, where they are characterized by the presence of evenly distributed white to pink microcline phenocrysts about 1 cm long.

The granodiorite is a light grey, equigranular rock composed of plagioclase, quartz, hornblende and biotite. The granodiorites in the southern half of the stock are essentially biotite-bearing, whereas, in the northern half, they become progressively enriched in hornblende. The granitic rocks also contain sparsely distributed elongate mafic inclusions that range from one to several tens of centimetres in length (Photo 15). From field observations, the compositions of the inclusions, have been estimated to range from hornblende-rich diorite to hornblendite. The inclusions show little compositional variation throughout except for a biotite-rich variety found at a rock cut on Highway 11 in Oakes Township. The inclusions are not xenoliths. No rocks similar to these have been observed in the area. They are therefore presumed to have been derived from a deeper portion of the Croll Lake stock, or are the result of mixing of mafic and felsic magma. The plagioclase of the granitic rocks of the Croll Lake stock is zoned in an oscillatory manner, indicating fluctuations in bulk composition of the granitic liquid. This supports the theory of mixing of two separate magmas.

Accessory minerals in the granitic rocks are titanite, epidote, apatite, magnetite and zircon. Myrmekite is also common and locally mantles plagioclase crystals. In one locality, just outside the map area on land of the Ginoogaming First Nation, macroscopic titanite crystals up to 8 mm long with diamond-shaped cross sections have been found.

Dikes of aplite have been found in the central part of the stock, northeast of Croll Lake. Quartz and quartz-feldspar porphyry dikes are found in the southern part of the stock. These may be genetically related to the stock as suggested by recent geochronological work (*see* Geochronology section).

In Oakes Township, a distinct foliation is present in the granodiorite. The long axes of the elliptical mafic inclusions are parallel to the foliation, indicating that the original shapes of these inclusions were probably spherical.

Late fractures filled with quartz-tourmaline, epidote or alkali feldspar are common near, and within, the Croll Lake stock.

It is here suggested that the Croll Lake stock is an apophyse of the Onaman–Twin Lake batholithic complex to the north of the area.

OTHER GRANITIC INTRUSIONS

Granitic rocks are also found in the northwest and northeast corners of Houck Township and the northeast corner of Oakes Township. Most of these rocks represent apophyses of the Onaman–Twin Lakes batholithic complex that lies outside the map area to the north.

Several outcrops of strongly lineated leucogranite are found in northwest Houck Township, approximately 800 m west of Alfred Lake. This leucogranite, extending to the west of Houck Township, has previously been described by Beakhouse (1989). Several outcrops of trondhjemite occur on the west shore of Alfred Lake, approximately 2 km south of the northwest corner.

A small, poorly exposed granitic body lies in the northeast corner of Houck Township. The continuity of the intrusion beyond the map area is not known. Modal determinations on two samples give compositions of monzodiorite and granite.

Mineral Veins

Within the map area, mineral veins are very common in all Archean rock types. By far the most common vein mineral is quartz, which is usually white or grey. Most quartz veins were emplaced before or during the tectonic event that produced the present structure of the Beardmore–Geraldton belt. These veins have been invariably boudinaged, folded and transposed (Photo 16). Disrupted veins are found locally as irregular lenses, pods or masses within highly foliated rocks. The veins carry various amounts of calcite, ankerite, alkali feldspar, black tourmaline, sulphides and gold. Pyrite is the most common sulphide present in quartz veins but pyrrhotite, chalcopyrite and arsenopyrite have also been found or reported. At Mineral Lake, small amounts of molybdenite occur within tourmaline-bearing quartz veins. South of Gauthier Point of Long Lake in Oakes Township, a 15 cm wide vein containing an amethyst variety of quartz was found to carry pyrite, chalcopyrite and tetrahedrite. Small, undeformed veins of quartz, quartz-tourmaline, epidote and albite are common in the vicinity of the Croll Lake stock.

Gold mineralization is most commonly associated with quartz veins within the map area. Because of its economic importance, this association is discussed in detail in the economic section of this report.

Proterozoic

Proterozoic rocks cutting the Archean rock types are represented by dikes: 1) Rocks of alkalic and ultrabasic affinity, 2) diabase dikes of which two intrusive swarms may be distinguished, 3) a breccia occurrence in Oakes Township which may be related to a diatreme structure.

Photo 16. Parallel system of deformed quartz veins in metawacke. Where the vein cuts magnetite iron formation, sulphides are abundant and are associated with gold mineralization. This quartz veining is depicted on Figure 19. Geraldton Longlac Gold Inc. property, west trenches, northern Coltham Township.

Alkalic and Ultrabasic Dikes

A relatively small number of alkalic and ultrabasic dikes, namely lamprophyres, syenitic rocks and a carbonatized ultramafic rock have been found to cut Archean rocks.

LAMPROPHYRE DIKES

Four lamprophyre dikes have been noted within the map area: two are exposed on the western shoreline of Long Lake; one in a gravel pit off the Crib Road, 400 m away from the intrusive contact of the Croll Lake stock; and one cuts gabbro in eastern Oakes Township. The dikes range in thickness from 10 to 50 cm and are dark grey to black.

Petrographic examinations reveal similar textures and mineralogies for all four dikes. The rocks are porphyritic, containing up to 40 percent rounded, light-coloured phenocrysts; under the microscope these were found to consist almost entirely of fine-grained carbonate with minor opaque grains. The phenocrysts are degraded olivines that have been replaced by magnesite. Identifiable essential matrix minerals are brown pleochroic mica, being either biotite or iron phlogopite, and magnetite. The lamprophyre found in Oakes Township also contains a radiating, fibrous pleochroic mineral, probably amphibole. These rocks have been classified as lamprophyres based on the fact that they contain essential biotite or iron phlogopite. They do not fit into any of the main lamprophyre types described by Streckeisen (1979), mainly because of their high olivine content.

SYENITE DIKES

Fine-grained dikes have been found in two places at Long Lake. South of Suicide Bay, on the Oakes–Abrey township line, three narrow dikes about 10 cm thick cut granodiorite of the Croll Lake stock. These dikes have a red-brownish colour with a cherty appearance, and are marked by a 1 cm thick, dark grey contact zone with the granodiorite. A fine- to medium-grained 3 m wide dike, similar to the dikes near Suicide Bay but with a much higher mafic mineral content, has been found on the western shoreline of Long Lake at the Northern Narrows.

Petrographic examinations of the dikes near Suicide Bay reveal that the main component of the rock is altered potassium feldspar which occurs as slender crystals giving a trachytic texture. Millimetre-long, euhedral orthoclase phenocrysts are sparsely distributed throughout. The red colour is given by hematite. A hairline fracture is filled with purple fluorite. The dike at the Northern Narrows is mainly a plagioclase-rich rock with approximately 25 percent mafic components, including chloritized hornblende, biotite and magnetite.

Chemical analyses performed on the two rock types reveal strongly contrasting chemistries of both the major and trace elements (*see* samples 5B and 5C in Appendix 4F). The dikes near Suicide Bay have the composition of syenite with equal sodium and potassium contents, whereas the dike at the Northern Narrows is silica poor (45.4 weight percent SiO_2) and iron-rich (14.6 weight percent FeO_t). The latter is also strongly enriched in phosphorus (1.89 weight percent P_2O_5), barium (1700 ppm) and strontium (1306 ppm). On the other hand, the syenite near Suicide Bay has a very high zirconium content of 1153 ppm.

The Suicide Bay syenite dikes conform to a description of similar dikes that cut rocks of the Port Coldwell alkalic intrusion. These later dikes also contain purple fluorite (R.P. Sage, Ontario Geological Survey, personal communication, 1987). These analogies may indicate that the syenite dikes have a maximum age of ca. 1108 Ma, according to high precision radiometric dating performed on the Port Coldwell complex (Heaman and Machado 1987).

CARBONATIZED MICA PERIDOTITE

A northerly striking, 50 cm wide dike with a thick limonitic weathered surface transects granodiorite of the Croll Lake stock in a rock cut on Highway 11 in southwestern Oakes Township. On a fresh surface, the rock is grey, with a peculiar texture given by rounded pellet-like bodies that are up to 1 cm across. Shiny black mica flakes and, more rarely, rounded mica phenocrysts up to 1 cm in diameter are sparsely distributed throughout. A polished surface of the rock (Photo 17) brings out the texture of the rock. The pellet-like bodies form approximately 40 percent of the rock.

Under the microscope, the pellet-like bodies are found to consist entirely of very fine-grained carbonate which displays a fine texture that is similar to altered olivine. X-ray diffraction analysis confirmed that the carbonate species is magnesite. According to Deer et al. (1962), magnesite replaces olivine under low to medium metamorphic conditions in which CO_2 is available. Because the dike in Oakes Township has not been metamorphosed, the authors believe that the peridotite has been altered by deuteric processes. The inter-olivine matrix consists of carbonate, which staining revealed to be chiefly ankeritic dolomite, phlogopite and a fine-grained sulphide, probably pyrite. Very sparsely distributed magnetite grains, to 3 mm across, also occur. This rock has many compositional and mineralogical similarities to the lamprophyres described above, but differs from them in its lower mica and higher pseudomorphosed olivine content.

Photo 17. Polished slab of carbonatized mica peridotite from a dike cutting granodiorite of the Croll Lake stock. The light-coloured, rounded bodies are magnesite pseudomorphic after olivine; the black bleb is a biotite or phlogopite phenocryst. The dark layer in the middle of the photograph is mica-rich. Oakes Township, near Highway 11.

One sample (sample 5A) of carbonatized mica peridotite has been analysed. Results are shown in Appendix 4F. The rock is characterized by low silica (21.60 weight percent) and high MgO (17.00 weight percent) and TiO_2 (2.58 weight percent) contents. It also is enriched in K_2O (2.21 weight percent), which is a constituent of phlogopite. The highly carbonatized state of the rock is evidenced by a CO_2 value of 30.70 weight percent. The rock is strongly enriched in Cr (730 ppm), Ni (620 ppm) and Zr (696 ppm), with respect to average crustal rocks.

DIATREME BRECCIA

Breccia zones, up to several centimetres wide and hosted by metamorphosed mafic metavolcanic rocks, occur in central Oakes Township just south of the Trans-Canada Pipeline. A polished hand-specimen exhibits unsorted, highly angular clasts which are 1 mm to several centimetres across. The clasts range from a cream white to dark green in colour and are very fine grained. The matrix to the clasts is light green and microcrystalline. A thin section of the breccia reveals extremely angular fragments with compositions from quartz microclasts to larger polymineralic clasts composed of feldspar, amphibole, quartz and epidote. The lack of fabric in this breccia, which is hosted in metamorphosed and deformed metavolcanic rocks, suggests that it has a postmetamorphic origin. It is here suggested that the breccia formed by a phreatomagmatic process related to Proterozoic alkalic magmatism that is manifested by the intrusion of lamprophyre, peridotite and syenite dikes.

One sample of breccia (sample 5D) has been submitted for whole rock chemical analysis. The values are listed in Appendix 4F. Its composition does not show any anomalous values except for a relatively elevated chromium value of 282 ppm.

Diabase Dikes

Numerous diabase dikes, up to 50 m wide, cut the Archean rocks in a north to northwesterly direction. Diabase exposures are commonly rounded rock knobs or ridges. The thicker dikes may be traced in outcrop for up to several kilometres, but because these rocks weather easily, their extent and pattern can only be resolved from high resolution aeromagnetic maps. By using magnetic maps obtained from the Assessment Files Research office, individual dikes within the map area have been traced for up to 10 km. Based on petrological differences and some field relations, two types of diabase of probably different ages have been distinguished: 1) a porphyritic type and 2) a non-porphyritic variety. In the field it is not always possible to unambiguously distinguish between the porphyritic and non-porphyritic kind—especially in small outcrops—due to the inhomogeneous distribution of phenocrysts in the porphyritic variety.

PORPHYRITIC DIABASE

Plagioclase-phyric diabase occurs as dikes ranging up to several tens of metres in width. The texture ranges from aphanitic in narrow dikes to coarse-grained in dikes which are at least several metres wide. The wider dikes have dark-coloured chilled margins. Medium- to coarse-grained diabase has an intermediate grey colour with a greenish tinge imparted by plagioclase. Locally, the weathered surface is orange due to the weathering of ferromagnesian minerals. The dikes carry inhomogeneously distributed subhedral to euhedral apple-green plagioclase phenocrysts that may be up to 3 cm across. Phenocrysts may locally be found in large concentrations near the dike margins, but more commonly are sparsely distributed or isolated in equigranular diabase. Plagioclase phenocryst-bearing dikes may also be distinguished by their weakly magnetic character.

Petrographic examination of thin sections shows 50 to 75 percent plagioclase (labradorite) subophitically enclosed by augite. Hornblende is seen as a partial, deuteric replacement of augite. Lesser constituents are magnetite, and interstitial quartz and biotite. In northeastern Coltham Township, a 0.3 m wide dike, with up to 5 mm long lath-shaped plagioclase phenocrysts, has been found to contain altered olivine.

NON-PORPHYRITIC DIABASE

The non-porphyritic dikes are distinguished from the porphyritic ones by 1) their lack of larger plagioclase phenocrysts, 2) a generally brown colour on the fresh surface and a commonly orange weathered surface, 3) the absence of post-diabase mineral-filled fractures and 4) higher magnetite content than the porphyritic variety. In thin section, they are distinguished by higher clinopyroxene contents, lesser biotite and little or no quartz.

RELATIONS AMONGST THE DIABASE DIKES

According to Fahrig (1987), dikes of three types may be found in the map area: 1) Matachewan-swarm dikes, 2) Marathon-swarm dikes, and 3) Keweenawan-swarm dikes.

The north to northwest-trending Matachewan dikes belong to one of the largest dike swarms in the Canadian Shield and are believed to be older than 2000 Ma (Fahrig 1987). These have been described as plagioclase porphyritic (L.S. Jensen, Ontario Geological Survey, personal communication, 1988) and it is therefore likely that the porphyritic dikes in the map area belong to the Matachewan swarm. Dikes from the Marathon swarm are poorly documented but some have been described as having a komatiitic composition (Fahrig 1987). The non-porphyritic dikes have mineralogy and texture that is identical to that of the Nipigon Sills (Sutcliffe 1986) and dikes found north of Beardmore (Kresz and Zayachivsky 1989) suggesting that they are of the Keweenawan, rather than the Marathon, swarm.

Six samples of various dikes throughout the map area have been analyzed; the results are listed in Appendix 4E. On the AFM diagram (*see* Figure 3A) and on the Cation plot (*see* Figure 3B), the analysed samples cluster tightly in the field of iron tholeiites. Almost all analyses fall within a narrow compositional range and the rocks are slightly quartz normative.

PHANEROZOIC

Cenozoic

QUATERNARY

Pleistocene

The crust in the Geraldton area has been stable since the Proterozoic, and has undergone extensive erosion. During the last ice age, the Precambrian peneplain was scoured by thick continental glaciers. Glacial striae on flat bedrock surfaces indicate that the general direction of the latest ice movement was from the northeast. Erosional and depositional features from the latest ice sheet have contributed to the present land forms. Amongst these are linear erosional features that are lithologically and structurally controlled, such as Long Lake, smooth rock knobs and gently undulating hills, esker and kame deposits, and drumlins.

The glacial sediment cover is represented by till, glaciofluvial and glaciolacustrine deposits. The various terrain features are described by Gartner (1979).

TILL

According to Gartner (1979), till deposits in the present map area are found mainly in Houck, northwestern Croll and western Coltham townships. The till, representing ground moraine, forms a thin blanket overlying bedrock. In Houck Township, sandy lacustrine deposits cover the till in places (Gartner 1979). To the west of Long Lake in Coltham Township, the till has been described as drumlinized. Near Forrester Lake, a short, steep sandy ridge has been interpreted as an ice crevasse fill.

GLACIOFLUVIAL DEPOSITS

Ice contact landforms are found in the western part of the map area where they are represented by gravelly kames in association with southwesterly trending eskers. Good examples are found on the Eldee Road in Coltham Township, on the northern arm of Kenogamisis Lake near Crib Lake, and in Houck Township where these deposits have been used as a source of sand and gravel.

GLACIOLACUSTRINE DEPOSITS

A large portion of the map area including Oakes, Croll and Abrey townships are covered by glaciolacustrine lake plain deposits of ancient Lake Nakina (Gartner 1979). South of Suicide Bay of Long Lake, these deposits occur as varved clays.

Holocene

Recent deposits, i.e., those which formed after the retreat of the latest ice sheet, are mainly represented by reworked glacial sediments such as sandy and silty stream deposits and beach deposits. Organic deposits (peat) have formed where the water table is at, or above, ground level in areas of swamp, marsh or muskeg; these are most extensive in Houck and Croll townships.

Structural Geology

REGIONAL STRUCTURAL SETTING

The map area comprises a complete section of the Beardmore-Geraldton belt, a distinct linear metavolcanic-metasedimentary assemblage which is approximately 180 km long and 30 km wide east of Lake Nipigon. The Beardmore-Geraldton belt is bounded to the north by the Tashota-Onaman terrane (Amukun 1980), a typical greenstone-plutonic assemblage, and to the south by the Quetico Sedimentary terrane. Since the formal subdivision of the Canadian Shield into constituent subprovinces (cf. Stockwell 1964), the Wabigoon-Quetico subprovince boundary has been drawn at the southern margin of the Beardmore-Geraldton belt (Ayres 1969) marking the change from predominantly volcanogenic to predominantly epiclastic rocks (Mackasey et al. 1974). The nature of this boundary later became the subject of debate (cf. Kehlenbeck 1976; Blackburn and Mackasey 1977).

Structural studies carried out by Williams (1986, 1987) and Devaney and Williams (1989) have shed new ideas on structural styles in the Beardmore-Geraldton belt and the adjacent Quetico Sedimentary terrane. Based on the tectonic model proposed, the Beardmore-Geraldton belt represents a tectono-stratigraphic transition zone between the Wabigoon and Quetico subprovinces. Ayres (1969), in this respect, pointed out that metasedimentary units in the Beardmore-Geraldton belt are "tongues" of the Quetico Belt metasediments. The structure of the Beardmore-Geraldton belt, and hence of the map area, is represented by a sequence of alternating east-trending metavolcanic and metasedimentary units.

Williams (1987) and Devaney and Williams (1989) suggest that the present structure of the Beardmore-Geraldton belt is the result of fault-derived stratigraphic repetition, produced by imbrication of thrust slices at the southern margin of a volcanic arc (the Tashota-Onaman terrane) flanked by a subduction-related accretionary prism of turbidites represented by the Quetico Sedimentary terrane. The nature of the metavolcanic-metasedimentary unit boundaries is uncertain due to poor exposure, but is believed to be sheared. In Legault Township, Devaney (1987) recognized a basal conglomerate at a contact between mafic metavolcanic rocks and overlying sedimentary rocks which indicates, at least in part, their non-conformable relationship.

The most significant structural features of the Beardmore-Geraldton belt are extensive shear systems associated with regional faults that parallel, or are at low angle to, the supracrustal sequence, such as the Paint Lake fault (Williams 1986; Reilly and Williams 1986), Watson Lake fault, Blackwater River fault and the Bankfield-Tombill fault (Buck and Williams 1984; Buck 1986). Two such shear systems, referred to as deformation zones in this report, have been defined within the present map area.

GENERAL STRUCTURE OF THE MAP AREA

The map area underlies a portion of the Beardmore-Geraldton belt, and its overall structure, given by east-trending lithologic units, is representative of the belt. In the north of the area, bedding in sedimentary rocks is generally steep to vertical, whereas to the south, beds become overturned reaching southerly dips on the order of 60°. Stratigraphic top determinations, obtained from graded sandstone beds throughout the belt, indicate that the supracrustal package, as a whole, is north facing (Williams 1986, 1987). A pervasive penetrative metamorphic cleavage is coplanar to the lithologic layering throughout the area (*see* Figure 13a and Figure 13b).

Two east-trending deformation zones that are associated with prominent regional faults have been defined to the north and south of the Croll Lake stock, based on strong planar and linear fabrics and asymmetric structures. These deformation zones are regarded as easterly continuations of ductile shear systems that host the gold deposits of the Geraldton Camp.

A prominent fault underlying Long Lake, informally referred to as the Long Lake fault, transects the east-trending supracrustal rocks at an angle of about 30°, and the Croll Lake stock. The Croll Lake stock is an elliptical granitic pluton, underlying a large part of the map area, whose long axis parallels the trend of the intruded supracrustals.

Deformation Zones

The tectonic activity that resulted in the regional deformation of the Archean terranes has subjected the Beardmore-Geraldton belt to large-scale, inhomogeneously distributed strain. Deformation, for the most part ductile, is pervasive; its intensity, which is variable across the belt, may be evaluated on a local scale using strain states of primary structures such as pillows, dikes and veins, clasts and intersecting fabrics (cf. Lister and Snoke 1984), but it is difficult to quantify for the entire belt.

Williams (1987) and Devaney and Williams (1989) noted that lithological contacts have accomodated much of the strain during tectonism. Observations made in the field indicate that much of the deformation has been dissipated in discrete shear zones that are commonly sharply bounded by much less deformed rocks. Along regional faults, such as the Paint Lake fault (Mackasey 1975) or the Bankfield-Tombill fault (Pye 1952; Horwood and Pye 1955), the spacings between discrete shear zones, which may attain considerable widths, are reduced and commonly coalesce. The deformation zones of this report are analagous to these regional, fault-related shear systems. Within the map area, two such deformation zones have been recognized, based on fabrics and various kinematic indicators. The two zones are the Barton Bay deformation zone (Macdonald 1983a), which is associated with the Bankfield–Tombill fault in the Geraldton area, and the Burrows River fault (Beakhouse and Chevalier 1983a; Beakhouse 1989).

Strain, as indicated by numerous rotated structures such as asymmetric folds, transposed layering, boudinage, and extension lineations, clearly indicates simple (rotational) shear. The direction of transport has been established mainly from extension lineations and asymmetric fold axes. However, the amount of horizontal offset has not been determined due to the layer-parallel movement. An apparent offset of Proterozoic diabase dikes in fault zones has been noted elsewhere within the Beardmore–Geraldton belt, which led some to believe that the faults were still active during the Proterozoic (Mackasey 1975, 1976; Williams 1987). No evidence of dike offset was found in the present map area.

THE BARTON BAY DEFORMATION ZONE

In the Geraldton area, the Bankfield–Tombill fault has been defined by Horwood and Pye (1955) as a "strongly sheared and brecciated zone" 40 feet (12 m) wide, dipping to the south at 70° as defined from drill hole intersections south of the Hardrock Mine. However, structural studies by Lavigne (1983), Buck and Williams (1984) and Buck (1986) in the Geraldton area suggest that the Bankfield–Tombill fault is represented by a "lithotectonic" package up to 5 km wide which has been referred to as the "Barton Bay Deformation Zone" by Macdonald (1983a). This lithotectonic package is defined by anastomosing shear zones with intervening areas of less deformed to undeformed rocks (Williams 1987). The oblique sense of shearing with a dextral horizontal component has been clearly established from fabric relationships and various kinematic indicators (Buck 1986; Williams 1987).

Within the map area, the Barton Bay Deformation Zone (BBDZ) is well exposed along the shore of Long Lake where simple shear strain indicators are found over a 2 km width on the west shore of the lake. On the east side of Long Lake, a deeper part of the BBDZ is exposed due to uplift of the crustal block east of the Long Lake Fault; there the BBDZ may be as much as 4 km wide. According to the various deformation structures found in the field, the BBDZ parallels the Southern sedimentary unit north of the Eldee Lake volcanic unit. Its boundaries also coincide with the lithologic contacts between the metavolcanic and metasedimentary rocks (*see* Figure 2).

The Barton Bay Deformation Zone West of Long Lake

Bedrock exposure that permits the examination of structures related to the BBDZ occurs in two areas: 1) the area between Birch Bay and Westside Bay of Long Lake (*see* Figure 5) where much rocky shoreline is exposed, and 2) in the overburden-stripped areas in north-central Coltham Township (*see* Figure 6 and Figure 18). The rock types, mainly represented by sediments that are characteristic of Archean submarine fans, are similar in both areas as are many tectonic structures.

Each rock type within the BBDZ has responded differently during deformation: massive arenites, rich in quartz and feldspar (*see* Photo 5 and Photo 7), and other homogeneous rocks that lack any original layering such as feldspar porphyry and cumulate-textured pyroxenite, have proven to be resistant to deformation. On the other hand, non-homogeneous rocks such as conglomerate, and rocks with a high percentage of labile constituents (wacke, lithic arenite, mudstone, basalt), have been highly sheared into chlorite-sericite schist (Figure 10 and Figure 11). These rocks are rich in phyllosilicates (mica, chlorite) which acted as "lubricants" during deformation.

Iron formation, represented by either single (*see* Photo 10) or multiple layers (*see* Photo 9) of fine-grained magnetite and quartz, have generally been highly deformed. The thicker single layers have typically been thickened and thinned along strike and occur as highly elongated lenticular bodies rather than uninterupted layers. However, as supported by their magnetic expression (ODM–GSC 1963a, 1963b), iron formation is confined to certain stratigraphic positions thus indicating that it may have been originally deposited as continuous horizons within the stratigrapic sequence.

Few clues are available to estimate the original thickness of the iron formations. Field observations indicate that the swelling in magnetite units has been produced by folding of the less competent iron formation between competent quartzofeldspathic sandstone. The asymmetry of the folds is always Z-shaped. The incompetent behaviour of iron formation during deformation is believed to have taken place through continual recrystallization of the intermagnetite quartz grains (cf. White et al. 1980) as magnetite itself is rather resistant to tectonic deformation. (Ramsay and Huber 1983). Various deformational structures associated with iron formation are shown in Photos 10 and 12, and in Figures 10 and 11, from overburden-stripped exposures in north-central Coltham Township.

Multi-layered iron formation of the area is characterized by alternating magnetite-rich bands and layers of fine-grained clastic sediment (*see* Photo 9). The magnetite layers are of uniform thickness, i.e., a few millimetres thick. H.R. Williams (Ontario Geological Survey, personal communication, 1987) has shown that similar iron formation bands in the Beardmore area thin out over distances of several metres. Williams (1987) also cites compelling evidence to suggest that the observed magnetite bands represent a highly transposed earlier layering, presumably bedding. Caution must, therefore, be used before implying bedding for all bedding-like layers. In the overburden-stripped area of north-central

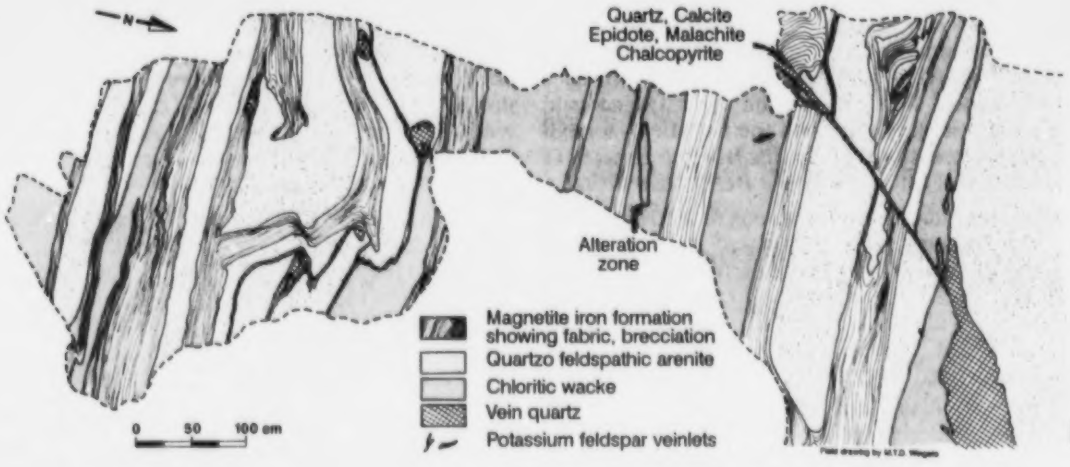

N
Quartz, Calcite
Epidote, Malachite
Chalcopyrite
Alteration zone
Magnetite iron formation showing fabric, brecciation
Quartzo feldspathic arenite
Chloritic wacke
Vein quartz
Potassium feldspar veinlets
0
50
100 cm

Figure 10. Field drawing of exposed bedrock in an overburden trench (*see* trench 2, Figure 6 and Figure 7 (back pocket)) on the Geraldton Longlac Gold Inc. property, northern Coltham Township. The drawing shows various deformation structures that are associated with magnetite iron formation and clastic metasediments. The structure on the left represents a sandstone tongue that delaminated the iron formation during dextral shear. The quartz pods represent highly disrupted veins.

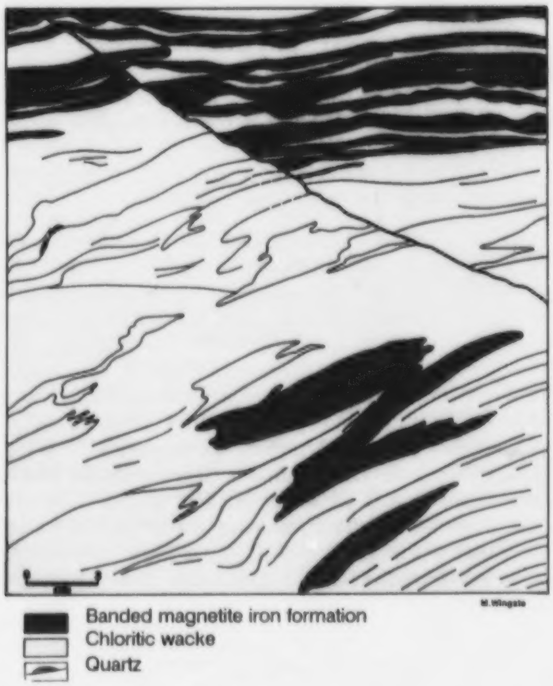


Figure 11. Field drawing showing the detailed structure of iron formation in a highly immature chloritic clastic metasediment; both rock types show a highly disrupted structure due to shearing. Geraldton Longlac Gold Inc. property, northern Coltham Township (*see* trench 8, Figure 6 and Figure 7 (back pocket)).

Coltham Township, shown in Figure 6 and Figure 7 (back pocket), thin, highly discontinuous bands of magnetite in coarse arenite attest to high degrees of deformation.

Much ductile deformation has also been dissipated in discrete shear zones that coincide with lithologic contacts. Good examples are found at Long Lake where the contacts between metasediments and coarse-grained albite-porphyry dikes are marked by zones of sericite schist in which the albite phenocrysts of the porphyry have been preserved in a micaceous matrix. It is conceivable that, because of the high degree of strain involved in the BBDZ, the porphyry dikes have become parallel to the regional east-trending structure. In turbidites, deformation has preferentially taken place in the mudstone-rich tops of the Bouma sequences, as indicated by a slaty cleavage, and in places, by offsets of crosscutting features such as quartz veins.

Structures and Kinematic Indicators Associated with the Barton Bay Deformation Zone

The intense deformation that took place within the BBDZ has produced various structures and fabrics that may be used to determine the sense of movement. Deformed polymictic conglomerates show clasts in deformation states that vary according to their composition (*see* Photo 8 and Photo 18). Fewer deformed clasts and phenocrysts may present pressure shadows, the asymmetry of which may be used as a kinematic indicator. Low-angle offsets, such as the ones shown in Photo 6, are commonly found in layered rocks. Z-shaped folds are commonly seen in wacke layers, iron formation layers (*see* Photo 12) and quartz veins. Quartz veins that were originally at a high angle to the layering have, in many cases, been transposed and boudinaged or been completely disrupted into lenticular or irregular pods, such as those illustrated in Figure 16. A variety of kinematic indicators have been found associated with iron formation and are illustrated on Photo 10 and Photo 12, as well as on field drawings shown in Figure 10 and Figure 11.

Mafic to Ultramafic Rocks Associated with the Barton Bay Deformation Zone

Several coarse- to very coarse grained mafic and ultramafic rock bodies representing cumulate-textured rocks occur within the sediments in the northern part of the deformation zone. Their petrology has been discussed above. This peculiar spatial association of ultramafic rocks with sediments coupled with the fact that the mafic to ultramafic rocks occur within the BBDZ suggests that they may represent tectonically emplaced wedges derived from a larger protolith, rather than individual magmatic intrusions. The following lines of evidence may be used to support this concept. 1) The individual units have a cumulate texture throughout, showing igneous layering and crystal size gradation in places. 2) The mafic to ultramafic rocks occur as three separate, east-trending lenticular bodies which are probably discontinuous along strike owing to their change in width over a short distance. 3) Igneous layering, which is commonly known only from large mafic-ultramafic intrusions, occurs in the relatively small units within the deformation zone (Figure 12). 4) The margins of the pyroxenite bodies in northern Coltham Township and at Birch Bay are extremely sheared, and in both places iron formation has been sheared into the cumulate rock (*see* Photo 11; Figure 7 (back pocket), trench 8).

The Barton Bay Deformation Zone East of Long Lake

The BBDZ has been offset in Long Lake by the Long Lake fault, producing a horizontal offset of 1 km and a more significant displacement in the vertical sense. East of Long Lake, the BBDZ from a deeper crustal level is exposed, as evidenced by rocks which have been recrystallized under amphibolite-grade metamorphism; by contrast, rocks west of the lake consist of greenschist mineral assemblages. The boundaries of the deformation zone have been established as the contact between

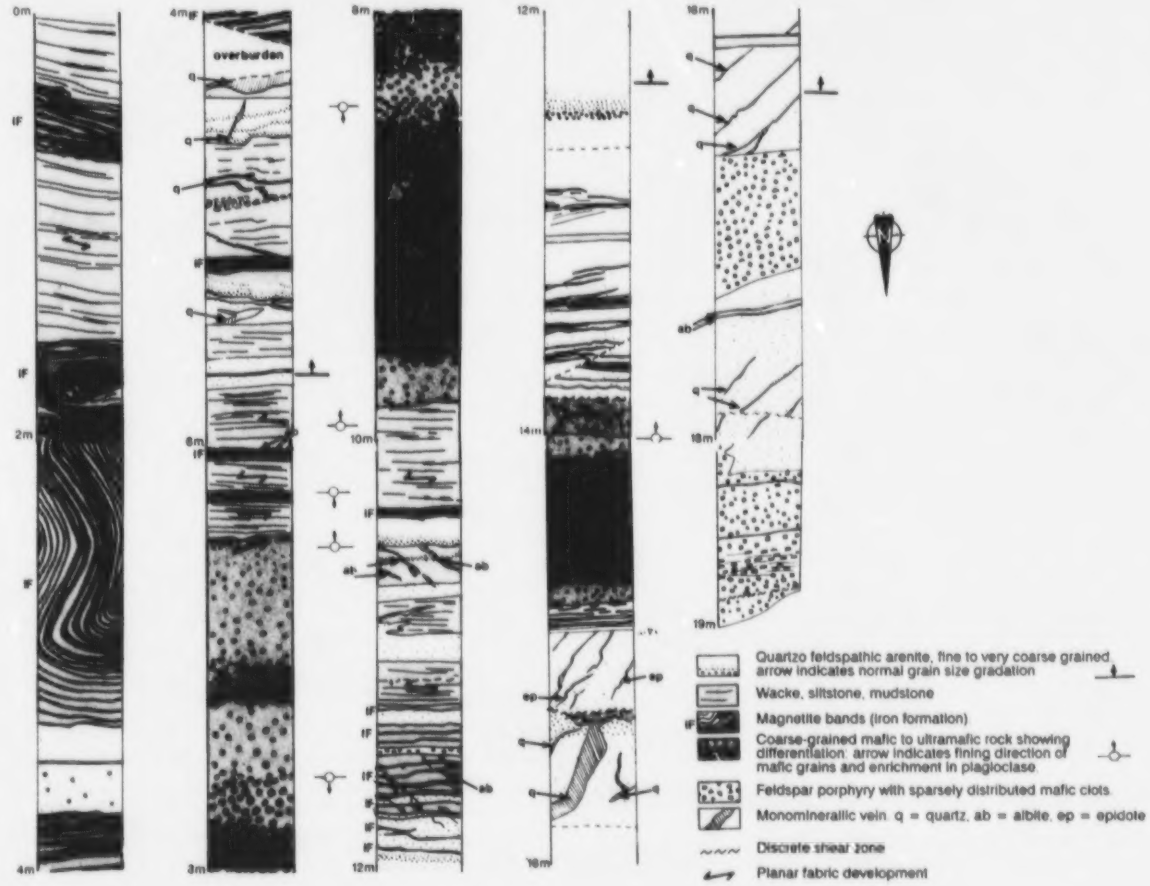

0m
IF
IF
2m
IF
4m
4m
overburden
q
q
q
IF
q
6m
IF
3m
8m
10m
IF
ab
ab
IF
IF
IF
IF
IF
IF
ab
12m
12m
14m
ep
ep
q
q
16m
16m
q
q
q
ab
q
18m
19m
Quartzo feldspathic arenite, fine to very coarse grained, arrow indicates normal grain size gradation
Wacke, siltstone, mudstone
IF
Magnetite bands (iron formation)
Coarse-grained mafic to ultramafic rock showing differentiation: arrow indicates fining direction of mafic grains and enrichment in plagioclase
Feldspar porphyry with sparsely distributed mafic clots
Monomineralic vein q = quartz, ab = albite, ep = epidote
Discrete shear zone
Planar fabric development

Figure 12. Detailed profile of the northern part of trench 5, Geraldton Longlac Gold Inc. property, northern Coltham Township (*see* Figure 6 and Figure 7 (back pocket)) showing the spatial association of the coarse-grained, mafic to ultramafic rocks, clastic metasediments and magnetite iron formation together with ductile and brittle structures that developed during deformation. Section length is marked at 2 m intervals.

the metasedimentary rocks and the metavolcanic rocks, where much strain is believed to have been locallized.

A strong penetrative mineral lineation, exhibited mainly by oriented hornblende, is present in the rocks on the east side of Long Lake.

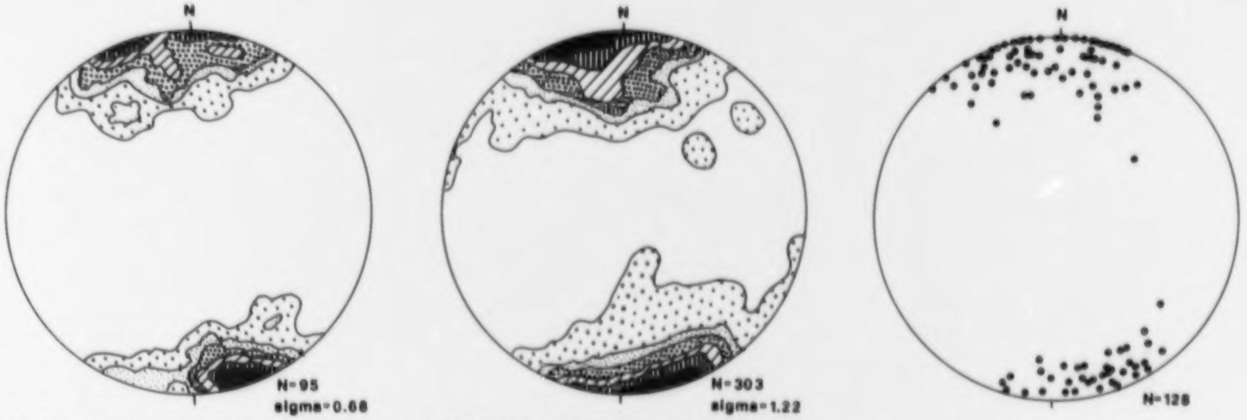
Layered rocks commonly display folds with amplitudes up to several decimetres and whose Z-shaped asymmetries indicate dextral movement (*see* Figure 16, Figure 17 and Figure 18). The orientation of fold axes (Figure 13E) is to the west at shallow to intermediate angles and is coaxial with stretch and mineral lineations (Figure 13 E,F).

Structures observed in iron formations are similar on both sides of Long Lake.

The more uniform distribution of penetrative fabrics associated with the rocks on the east side of Long Lake suggests that deformation was more homogeneous there than on the west side. This is compatible with the view that rocks at deeper levels in the earth's crust behave in a more ductile manner.

The Burrows River Deformation Zone

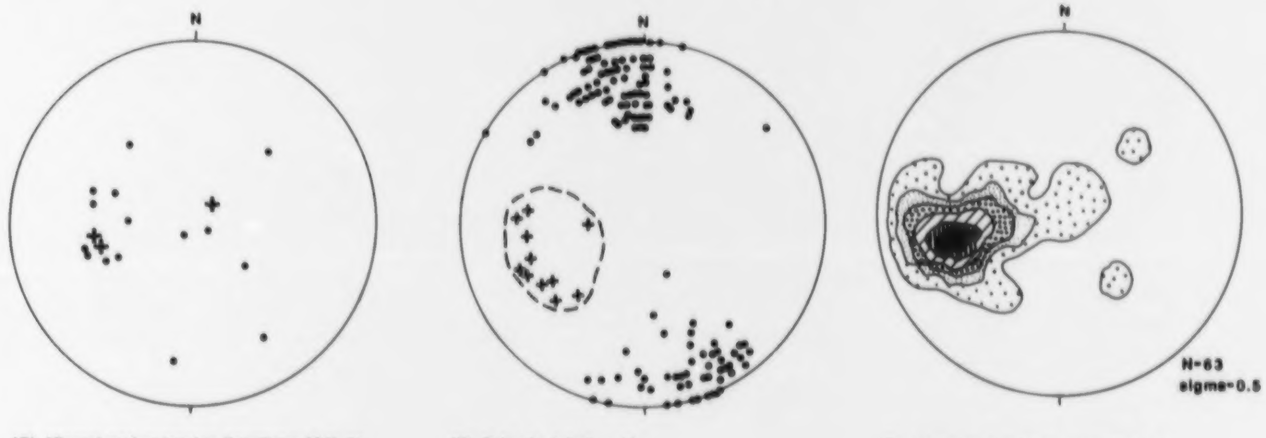
The Burrows River fault has been defined in McQuesten and Fulford townships by Beakhouse (1989). Poor outcrop exposure in the northern part of the map area does not allow the author to clearly define the fault and the width of its deformation zone whose boundaries, shown on Figure 2, are only approximate. Outcrops observed between the boundaries shown in Figure 2 indicate, however, that the rocks are, in places, highly



(A) Poles to bedding contoured at 2.4-4.1-7.0-9.1-12.3 poles per 1% area. Max. 14.1 poles

(B) Poles to foliation contoured at 5.5-8.0-13.0-18.0-27.5 poles per 1% area. Max. 42.0 poles

(C) Poles to foliation



(D) Mineral and extension lineations (•) N=14
Fold axes (+) N=3

(E) Poles to foliation (•)
Fold axes (+)

(F) Lineation densities contoured at 1.2-3.0-5.4-9.7-14.0 data points per 1% area. Max. 17.0

Figure 13. Projections of structural data from the northern Long Lake area (lower hemisphere, equal area net): a) total bedding measurements; b) total foliation measurements (foliations from the Croll Lake stock are excluded); c) foliation measurements north of the Croll Lake stock; d) lineation measurements, and axes from small asymmetric folds north of the Croll Lake stock; e) foliation measurements, and axes from small asymmetric folds south of the Croll Lake stock; f) mineral and stretch lineation measurements south of the Croll Lake stock.

strained. This is evident from strongly deformed pillows, disrupted quartz veins showing asymmetric folding, sheared porphyry dikes, and stretched clasts in conglomerate as observed north of Octopus Lake in Houck Township. In eastern Oakes Township, coarse fragmental rocks, believed to be tuff breccia, show highly elongated clasts (*see*Photo 3). To the west of the CNR line, the clasts are so highly deformed that the rocks appear to be banded. Rocks exposed along the Trans-Canada Pipelines' right-of-way lack any conspicuous linear fabric; this may be due to metamorphic recrystallization within the amphibolite thermal aureole of the Croll Lake stock, which possibly obliterated all pre-existing structures.

Nearly all kinematic indicators, including asymmetric structures from transposed and folded laminations and deformed quartz veins, indicate a dextral sense of horizontal movement.

Folds

Structural studies undertaken by Kehlenbeck (1986) in the Beardmore–Geraldton area, led him to suggest that the Beardmore–Geraldton belt is a fold belt representing a transitional terrane between the Quetico Subprovince and the Wabigoon Subprovince. Williams (1987), however, suggests that the belt is a north-facing tectono-stratigraphic sequence. If this is the case, than the lithologic repetition may not be accounted for by folding.

Fold structures have been inferred from stratigraphic facing reversals obtained in graded turbidite beds in the metasedimentary units. No stratigraphic top indicators were found in the metavolcanic units. Top reversals in the sedimentary rocks indicate that folding took place along the margins of the metasedimentary units. The metasedimentary rocks in northern Coltham Township, shown on Figure 7 (back pocket), are consistantly facing to the south for a distance of at least 200 m. Considering that the interlimb angle of the folds is very small, it is likely that the larger fold structures in the Southern sedimentary unit to the north of the Eldee Lake volcanic unit could have amplitudes on the order of several hundred metres. This is compatible with the larger fold structures mapped further west along strike, by Pye (1952) in Errington Township, and Horwood and Pye (1955) in Ashmore Township.

The geometry of the folds is believed to be asymmetrical, with westerly plunging axes such as in the folds west of the map area shown by Pye (1952) and Horwood and Pye (1955) and described by Macdonald (1984). Mesoscopic folds with centimetre- to decimetre-scale amplitudes, found throughout the Southern sedimentary unit, have westerly plunging axes at intermediate angles (*see* Figure 13E). These are believed to be coaxial with the larger scale folds whose axial traces have been inferred from opposing stratigraphic tops.

In contrast, metasedimentary rocks south of the Eldee Lake volcanic unit consistently face to the north, despite the fact that they have been overturned, i.e., dips are to the south. The style of folding described above is repeated in the Central and Northern sedimentary units and is continuous to the west of the map area (Beakhouse and Chevalier 1983a, 1983b). This style of folding may be extended throughout the rest of the Beardmore–Geraldton belt. The asymmetric, Z-shaped fold geometry with westerly plunging axes, and their spatial association with the margins of the metasedimentary units, is compatible with an imbricate thrust model for the Beardmore–Geraldson belt proposed by Williams (1987) and Devaney and Williams (1989).

Faults

THE LONG LAKE FAULT

A prominent fault, informally referred to as the Long Lake fault, is believed to underlie Long Lake; this is corroborated by the following evidence:

1. Long Lake defines a lineament nearly 70 km long; its maximum depth is over 167 m according to a bathymetric chart (MNR 1970); its depth increases progressively from north to south and reaches 107 m at the southern boundary of the map area.
2. The lithologic contacts of units crossing the Northern Narrows are offset by about 1 km in a sinistral manner; this offset is apparent on the aeromagnetic map (ODM–GSC 1963a).
3. There is an abrupt change in metamorphic grade from a greenschist assemblage west of Long Lake to an amphibolite assemblage east of the lake.

On a geological compilation map (Stott 1984a), the amount of offset of the units progressively increases southwards from the Croll Lake stock. The northern contact of the Croll Lake stock with the supracrustal rocks just north of Long Lake is not offset. It appears that displacement along the fault was oblique, with a strong dip slip component which resulted in the uplift of the eastern fault block relative to the western. No structures or fabrics that would unequivocally relate to the fault were found on either side of Long Lake. From rock unit offset relations, it appears that a portion of the fault is splayed at Second Island. The Long Lake fault is thus interpreted to be a hinge fault, whose pivot is located within the Croll Lake stock. A Proterozoic diabase dike, extrapolated by using its magnetic expression, across Long Lake north of Jackfish Bay (Discovery Mines Ltd., Assessment Files Research Office, Ontario Geological Survey) shows no offset. It is therefore believed that the fault is of Late Archean age, possibly being contemporaneous with the intrusion of the Croll Lake stock.

MINOR FAULTS

Small-scale, low angle offsets of metasedimentary strata are common within the Barton Bay Deformation Zone; this is illustrated in Photo 6. Small, conjugate thrust faults have been observed in rhythmically layered rocks. Small brittle offsets (*see* Photo 10; Figure 17) are ubiquitous throughout the map area.

Fabrics

During metamorphism and deformation, the rocks have developed a variety of planar and linear fabrics that may be used for a structural analysis of the area. The fabrics are described below as foliations and lineations.

Foliations

Most supracrustal rocks have acquired a schistosity which is particularly well developed in rocks with a high content of phyllosilicates. In places where the rocks are sheared, the fabric is generally very strongly developed. Most measured foliations parallel the east-trending supracrustal rocks. Within the metasedimentary units the foliations are nearly always coplanar with the measured bedding attitudes (*see*Figure 13A, Figure 13B).

Rocks within the deformation zones have commonly developed a strong schistosity. To the north of Indian Reserve No. 58, the metavolcanic fragmental units that have been metamorphosed to amphibole schists show, in most places along the unit, a marked banding that has resulted from the extreme elongation of clasts. Granitic rocks from the Croll Lake stock have also been foliated in the northern part of the intrusion. To the west of Suckle Lake, the foliations are north-trending and parallel the outline of the stock.

Lineations

Lineations have mainly been produced by:

1. stretching of mineral grains, phenocrysts or mineral clots, clasts, amygdules or pillows
2. oriented growth of minerals such as hornblende
3. crenulation and folding of layered rocks and veins

Lineations Associated with the Barton Bay Deformation Zone

Conspicuous lineations have been observed within the BBDZ. All have relatively shallow to intermediate plunges to the west (*see* Figure 13F). On the west side of Long Lake, the linear fabrics are mostly represented by stretched clasts in the conglomerates. Within highly sheared conglomerates, a peculiar, fine crinkling of the micaceous matrix to the clasts presents a shallow westerly plunge of about 15°. On the east side of Long Lake, mineral lineations imparted by oriented hornblendes are well developed in the amphibole schists. A very strong penetrative lineation produced by the stretching of lithic fragments, mineral aggregates and quartz phenocrysts has been noted within the felsic porphyry bodies in southeastern Abrey Township.

Both extension and mineral lineations are coaxial to axes of mesoscopic asymmetric folds throughout the BBDZ (*see* Figure 13E and Figure 13F). This is direct evidence of the sense of movement along the BBDZ which must have been oblique, north side over south, to account for this relationship.

Lineations Associated with the Burrows River Deformation Zone

In the northern part of the map area, lineations are well developed. Figure 13D is a plot of combined mineral and extension lineations, with fold axes from asymmetrically folded quartz veins. A collinear west-trending relationship is seen, implying that the movement along the Burrows River Deformation Zone (BRDZ) was similar to that of the BBDZ.

JOINTING

Joints are very common in all rock types. Prominent parallel joint sets have been observed within the Croll Lake stock, and have been recorded on Map 2538 and Map 2539 (Kresz et al. 1990a, 1990b). Bedrock exposed along the western shore line of Second Island in Long Lake displays sets of orthogonal joints that may be related to a nearby fault branching off the Long Lake fault.

TOPOGRAPHIC LINEAMENTS

Topographic linear features are shown on Map 2538 and Map 2839 (Kresz et al. 1990). They are not abundant between Geraldton and Longlac. The most prominent lineament is Long Lake, which is nearly 70 km long and reaches a maximum depth of 167 m (MNR 1970). This lineament is the physiographic expression of a fault which is parallel to the ice flow direction as indicated by glacial striations on the bedrock surface.

Metamorphism

All Archean rocks in the map area, with the exception of the Croll Lake stock, have been metamorphosed. The primary minerals of the supracrustal rocks have been degraded to secondary mineral assemblages that were stable under the prevailing conditions of the "Kenoran Orogeny". All supracrustal rocks have acquired a penetrative fabric that parallels the regional structure.

METAVOLCANIC ROCKS

To the west of Long Lake, mafic metavolcanic rocks and gabbro comprise the typical mafic greenschist mineral assemblage. From thin section examination it is seen that the secondary mineral paragenesis is quartz + albite + tremolite and/or actinolite + epidote and/or clinozoisite + calcite + titanite + sericite. East of Long lake, and within the metamorphic aureole produced by the Croll Lake stock and the Onaman–Twin Lake batholithic complex to the north of the map area, the rocks have been subjected to higher metamorphic grades that correspond to the upper lower grade of Winkler (1979), or to the lower "amphibolite facies". The typical mineral paragenesis is quartz + plagioclase + hornblende + epidote ± biotite ± calcite ± titanite. At Buckety Point, high concentrations of large garnets distributed along certain planes parallel to the schistosity are present in hornblende schist. These probably result from severe metasomatic alkali depletion.

METASEDIMENTARY ROCKS

Arenites and wackes have mainly quartzofeldspathic framework components that were little affected by low-grade metamorphism. Detrital plagioclase of low anorthite content has retained its pristine character, aside from little to moderate replacement by sericite (*see* Photo 5). Less mature rocks have compositions that approach those of mafic metavolcanic rocks, and therefore are similar to those in metamorphic mineral assemblages. In the field, these were described as chlorite-sericite schists. East of Long Lake, the rocks have generally been recrystallized. The quartzofeldspathic rocks have retained their original grain size; however, mafic sediments have recrystallized into hornblende schists or feather amphibolites. The typical metamorphic mineral paragenesis is quartz + plagioclase + hornblende + biotite ± almandine ± titanite ± calcite.

At the MacFarlane East gold occurrence (*see* Figure 14), high concentrations of almandine and chlorite are associated with quartz veins, a paragenesis which is stable under high pH (Winkler 1979). In three places, pelitic sediments have been metamorphosed to andalusite schists in which the following mineral paragenesis is observed: quartz + muscovite + biotite + andalusite + almandine. The contact metamorphic aureole of the Croll Lake stock is characterized by the presence of biotite and almandine over a distance of several hundreds of metres within the metasedimentary rocks.

GRANITIC ROCKS

A tonalitic intrusion, part of which is exposed in southeastern Abrey Township, has been metamorphosed. In thin section it exhibits plagioclase that is highly altered to sericite and epidote, and is partially recrystallized to secondary plagioclase. Primary hornblende has been replaced by secondary hornblende. It is probable, therefore, that the stock was intruded before the main metamorphic event.

On the other hand, the granodioritic Croll Lake stock reveals well-preserved primary minerals. Plagioclase is commonly somewhat altered; the alteration being more intense with increased anorthite content. A contact metamorphic aureole defined by the presence of hornblende, biotite, garnet and fresh plagioclase surrounds the Croll Lake stock.

METASOMATIC EFFECTS (ALTERATION)

Near Noel Lake, the presence of biotite in mafic metavolcanic rocks locally found in central Abrey Township probably indicates the introduction of potassium. The presence of garnet sugggests alkali depletion. Epidote-rich pillow cores in mafic metavolcanic rocks are common and suggest calcium enrichment. Gabbro exposures have revealed, in several places, circular patches enriched with green epidote; this epidotization is probably a deuteric effect. Rocks which have undergone shearing commonly show an abundance of one or several of the following: carbonate, silica, alkali feldspar and sulphides.

Correlation Between Geology and Aeromagnetic Data

Aeromagnetic maps have been of significant value in establishing lithological contacts in areas of poor bedrock exposure, and they are a good reflection of the general overall structure of the map area. A number of geological features may be distinguished on these maps (ODM–GSC 1963a, 1963b, 1965). More detailed company magnetic maps from the Assessment Files Research office of the Ontario Geological Survey, and assessment files from the Resident Geologist's office in Thunder Bay, were also used.

On government survey maps, the magnetic profiles have an easterly trend which is consistent with geological observations made in the field. The rock units which give the strongest magnetic expression are the metasedimentary units that contain magnetite iron formation. As a consequence, the Northern and Southern sedimentary units have a very high magnetic relief compared with the adjacent rock units. On the other hand, metasedimentary units with no iron formation, such as the Central sedimentary unit, cannot be distinguished from the metamorphosed metavolcanic rocks, based on their magnetic characteristics.

In northern Houck Township, the high magnetic expression produced by the iron formation in the Northern metasedimentary unit forks, which likely indicates that the unit splays into two branches at Marion and Houck lakes. The Southern sedimentary unit is magnetically distinct on either side of the Eldee Lake volcanic unit; on the north side, the strong anomaly produced by iron formation is continuous across the map area. Near the eastern boundary of the map area, at Milbean Lake, the anomaly is bent into a Z-shaped form probably indicating folding.

South of the Eldee Lake volcanic unit, the metasedimentary rocks have a very low magnetic expression which is similar to the expression given by the Quetico sedimentary terrane south of the Southern volcanic unit. West of Long Lake, the Southern volcanic unit stands out in high relief against the very low magnetic background of the Quetico sedimentary rocks. To the east of Long Lake, it is only weakly expressed, probably because of a somewhat higher magnetic background in rocks of higher metamorphic grade.

The outline of the Croll Lake stock is well defined against the supracrustal rocks. A gabbro intrusion, underlying the western margin of the Croll Lake stock in northwestern Abrey Township, stands out on the aeromagnetic map (ODM–GSC 1963a). The Long Lake fault is apparent from the bend of the magnetic lines that represent the iron formation in the Southern sedimentary unit, and is due to the higher magnetic background east of Long Lake.

On a magnetic map by Discovery West Corporation Limited (Assessment Files Research Office, Ontario Geological Survey), an east-trending magnetic ridge occurs just south of Abrey Township. This ridge is also an electromagnetic conductor. Drilling by Shell Canada in 1980 indicated the presence of pyrrhotite and pyrite associated with this feature (Assessment Files Research Office, Ontario Geological Survey).

North- to northeast-striking Proterozoic diabase dikes are poorly defined on the large scale government aeromagnetic maps (ODM–GSC 1963a, 1963b, 1965); however, they give a pronounced magnetic signature on detailed company maps.

Geochronology

According to a recent compilation of isotopic ages (Easton 1986), little geochronological data is available for the Geraldton–Longlac area or for the Beardmore–Geraldton belt as a whole. The only isotopic ages from within the map area that were published at the time of writing are three ages obtained from the Croll Lake stock. Two potassium-argon ages on hornblende and biotite are 2539 ± 61 and 2175 ± 48 million years, respectively (Wanless et al. 1974), while one rubidium-strontium age on potassium feldspar gave 2726 ± 250 million years (Hurley 1958).

Four high-precision U-Pb ages from zircon were recently obtained from felsic intrusive rocks of the area (F. Corfu, Royal Ontario Museum, personal communication, 1987). One granodiorite sample from Oakes Township yielded an age of 2690 million years and a feldspar porphyry from the west apex of the Croll Lake stock returned an age of 2698 million years. These two ages fall well within the error envelope of Hurley's (1958) rubidium-strontium age. Two other feldspar porphyry dikes, from the Macleod–Cockshutt Mine area at Geraldton and Eldee Lake in Ashmore Township, gave ages of 2690 and 2691 million years respectively. The latter age of 2691 Ma was obtained by Anglin et al. (1988).

At the time of writing, no radiometric ages of metavolcanic and metasedimentary rocks from the area are known. Some of the north-striking diabase dikes are of Keweenawan age, i.e., ca. 1108 million years (Davis and Sutcliffe 1985), whereas the plagioclase porphyritic diabase is older and is probably related to the Matachewan dike swarm emplaced more than 2000 Ma (Fahrig 1987).

The red alkalic dikes that cut the Croll Lake stock are identical to red syenite dikes cutting rocks belonging to the Port Coldwell complex (R.P. Sage, Ontario Geological Survey, personal communication) which have a U-Pb age of 1108 ± 1 million years (Heaman and Machado 1987).

Economic Geology

GOLD DEPOSITS

Several gold occurrences are known in the map area. Most have been found to be spatially associated with two, prominent, east-trending, fault-related lithotectonic zones: the Barton Bay Deformation Zone, which hosts the Geraldton gold camp; and the Burrows River Deformation Zone. Gold mineralization is also present outside the two deformation zones in an area referred to here as the Mineral Lake area, in southwestern Croll Township.

Within the map area, gold is found associated with 1) vein systems, 2) discrete sulphide-bearing shear zones, and 3) sulphide-bearing chert within metavolcanic rocks. Occurrences mentioned below are described in greater detail in the Property Descriptions chapter of this report.

Gold Deposits Hosted in Veins

GOLD OCCURRENCES ASSOCIATED WITH THE BARTON BAY DEFORMATION ZONE (BBDZ)

The largest concentration of gold occurrences is found in the southern part of the map area, along the BBDZ, where mineralization is predominantly associated with quartz veins. From west to east, three main zones of gold occurrences associated with the BBDZ may be distinguished:

1. an occurrence in north-central Coltham Township (Burroughs Syndicate occurrence)
2. occurrences in the Birch Bay–Westside Bay area of Long Lake
3. a series of occurrences on the east side of Long Lake known as the MacFarlane and Coniagas occurrences

Gold Occurrence in North-Central Coltham Township

In north-central Coltham Township, an easterly trending system of subvertical, parallel, auriferous, milky white quartz veins and lesser quartz-carbonate veins occurs. These veins are usually highly deformed (*see* Photo 16). They trend parallel to magnetite iron formation and chloritic siltstone. Where quartz veins are in contact with the iron formation, abundant pyrite has formed in the iron formation (Photo 18) (*see* Property Description: Geraldton Longlac Gold Inc.).

Gold Occurrences at Birch Bay–Westside Bay of Long Lake

At Westside Bay and south of Birch Bay of Long Lake, sheared clastic sediments host auriferous quartz-carbonate veins which form irregular stringers and veins up to 0.3 m wide. The veins occur parallel to the fabric of

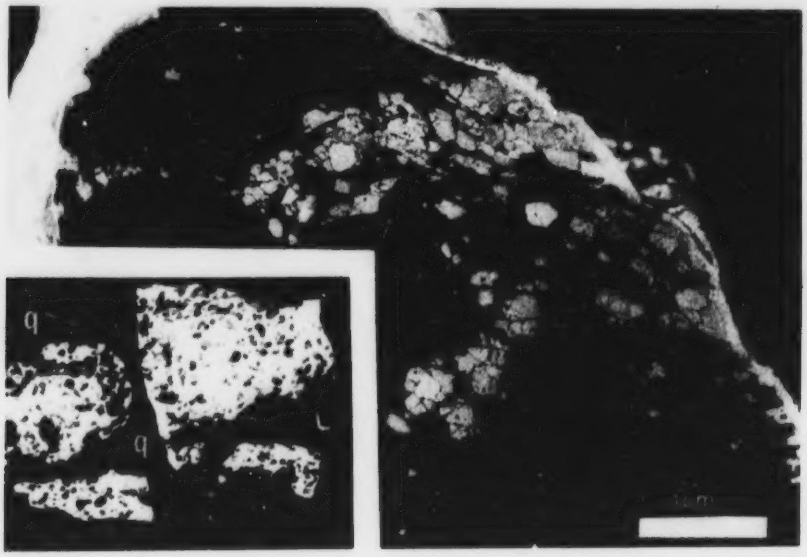


Photo 18. Pyrite replacement of magnetite in iron formation. The iron formation shown in this photograph contains abundant quartz fillings at the junctions of secondary fractures that clearly cut the pyrite grains. Gold mineralization is believed contemporaneous to this filling event. The main photograph is from a polished sample. The inset picture is a photomicrograph, using reflected light, showing the quartz-filled fractures (q) in pyrite. The dark grains within the pyrite are magnetite. The sample is from the mineralized zone shown in Figure 20.

the hosting metasediments, but are difficult to trace along strike due to limited exposure. They are composed of glassy to white quartz, calcite and ankerite. Small disseminated sulphide grains occur in the veins and make up less than one percent of the veins.

MacFarlane and Coniagas Occurrences

A series of easterly trending occurrences east of Long Lake are known as the MacFarlane and Coniagas occurrences (Figure 14). The occurrences described are now part of the Ferau Resources Inc. property.

The main type of gold mineralization at these occurrences is in quartz vein systems which contain local concentrations of carbonate and tourmaline. The veins are hosted by hornblende schists representing recrystallized immature clastic sediments. In places, fine-grained disseminated sulphides are found in the hornblende schist (*see* Figure 16 and 18).

At the MacFarlane East showing (*see* Figure 14), folded quartzofeldspathic sandstone and amphibole schist (*see* Figure 16) contain hornblende, as well as chlorite, garnet, tourmaline and sulphides. The rocks contain pods of white quartz that represent disrupted quartz veins. Highly anomalous gold values are associated with hornblende schists that contain disseminated sulphides consisting of pyrrhotite, pyrite, chalcopyrite and arsenopyrite. One sample (*see* Sample MF1; Figure 16) assayed 5280 ppb Au. Loose, vein quartz material in the dump beside the shaft contains concentrations of red garnet and green chlorite.

At the Coniagas West occurrence (*see* Figure 14), many pods and stringers of quartz and calcite are contained within small silicified shears in amphibole schist. These shears contain much fine-grained disseminated pyrrhotite and arsenopyrite (Photo 19).

Other Occurrences

Quartz veining is common along the northern and southern boundaries of the BBDZ. Clastic metasediments host a 10 cm wide vein of white quartz with pyrite on a small island in Long Lake, 3 km west of Third Island. A grab sample from this vein assayed 200 ppb Au.

Tourmaline is associated with numerous quartz veins north of the of the BBDZ. These veins occur in narrow, discrete, east- to northeast-trending shears in mafic metavolcanic rocks and within quartz-porphyry dikes. Some of the veins host pyrite and carry gold. Fairbairn (1938) described the presence of visible gold in the Birch Bay occurrence vein, now part of the H.E. Wil-

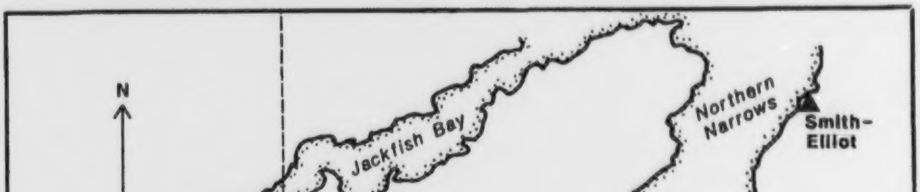

N
Jackfish Bay
Northern Narrows
Smith-Elliot
CROLL TP.
ABREY TP.
Long Lake
Birch Bay
COLTHAM TP.
Birch Bay
Long Lac Adair
First Island
MacFarlane East
Coniagas West
Coniagas East
MacFarlane West
Westside Long Lac
Westside Bay
Second Island
Third Island
gold occurrences
0
1
Kilometres

Figure 14. Location of gold occurrences at Long Lake; claims shown are patented.

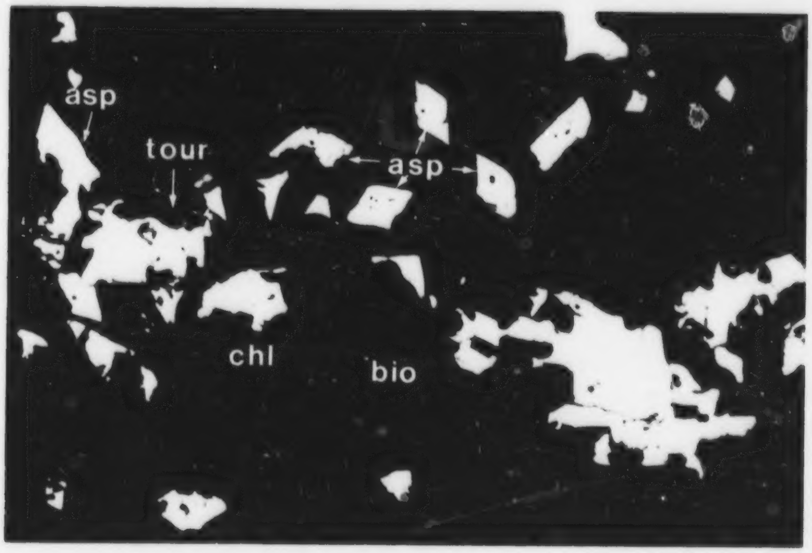


Photo 19. Photomicrograph, in reflected light, from a sheared and altered rock, mineralized with gold. The white metallic mineral, characterized by its diamond-shaped cross section, is arsenopyrite. Arsenopyrite crystals show late fractures which may be contemporaneous with gold mineralization. The non-metallic minerals include quartz, feldspar, biotite *(bio)*, muscovite, chlorite *(chl)*, tourmaline *(tour)*, titanite, garnet, and apatite. Coniagas west occurrence, Ferau Resources Inc.

helm property, and in the Smith–Elliot vein which is on the Ferau Resources Inc. property.

Quartz-carbonate and quartz-tourmaline veinlets within the BBDZ are present on a small island 500 m southeast of First Island in Long Lake, and along the east shore of Long Lake at the Northern Narrows. Quartz-tourmaline veinlets are associated with pyrite seams at the Sopko occurrence (M. Malouf property).

GOLD OCCURRENCES ASSOCIATED WITH THE BURROWS RIVER DEFORMATION ZONE (BRDZ)

Auriferous quartz veins occur in the eastern part of Oakes Township (W.W. Brinklow property). They are hosted by amygdaloidal basalt metamorphosed to amphibole schist. They are up to 20 cm in width, irregular in shape and consist of milky white quartz. Minor pyrite along the edges of the quartz veins has been noted, and small visible gold grains have been found by R.W. Brinklow (Prospector, personal communication, 1987).

In central Oakes Township, an auriferous quartz vein striking 080° (E.J. Duchene property), and carrying minor pyrite, chalcopyrite and sphalerite occurs in schistose metavolcanic rocks.

In eastern Houck Township, a gold-bearing quartz vein, known as the Dam occurrence (Coulson Exploration Incorporated property), occurs in the bed of the Kenogamisis River.

MINERAL LAKE AREA

Gold mineralization in western Croll Township, at the western end of the Croll Lake stock, is associated with a number of quartz veins. West of Mineral Lake, numerous quartz and quartz-tourmaline veins cut mafic metavolcanic rocks, gabbro and feldspar porphyry. Many of these veins carry local concentrations of pyrite and chalcopyrite, and lesser amounts of molybdenite and pyrrhotite. Gold occurs with the sulphides but is erratically distributed.

Near Forrester Lake, a series of quartz veins filling fractures in mafic metavolcanic rocks and gabbro, and exposed in numerous trenches, contain sporadic blebs of chalcopyrite and pyrite. Gold values as high as 200 ppb have been obtained from the sulphide-bearing quartz.

In the Mineral Lake area, gold mineralization does not appear to be spatially associated with either the BBDZ or BRDZ.

SULPHIDE-BEARING SHEAR ZONES

Shear zones carrying disseminated sulphides or sulphide seams occur within the BBDZ and BRDZ.

Numerous sericitized, east-striking shear zones, up to 1 m wide, are exposed on the west shore of Westside Bay and south of Birch Bay of Long Lake. Some carry small amounts of pyrite, pyrrhotite and chalcopyrite. Fairbairn (1938) reported "coarse visible gold" in a 2-inch wide shear from this location. Shear zones that are parallel to the lithologic trends and fabrics, occur in the sediments and along contacts between the sediments and albite porphyry dikes (*see* Figure 5).

Narrow, east-striking shear zones, commonly up to 0.3 m wide, occur at the MacFarlane and Coniagas occurrences (*see* Figure 14). The shears are hosted by hornblende schist and quartzofeldspathic sediments (*see* Figures 16, 17 and 18), and carry fine-grained pyrite, pyrrhotite, arsenopyrite and chalcopyrite.

Coarse sulphide seams occur at the Sopko occurrence (M. Malouf property) in Abrey Township. The occurrence, hosted by sericite schist, consists of a group of closely spaced coarse, massive, pyrite and sphalerite seams which also contain small amounts of chalcopyrite, pyrrhotite and gold. Some irregular quartz veins containing tourmaline are found with the sulphide seams. Some gold values from assays are presented in Table 2.

Pyrite seams also occur in narrow, discrete shear zones along the Kenogamisis River, approximately 1 km south of Noel Lake in Oakes Township.

SULPHIDE-BEARING CHERT

A recrystallized, sugary-textured chert horizon hosted by metavolcanic rocks, is exposed in eastern Oakes Township on the W.W. Brinklow property. The chert horizon, exposed in a small outcrop, is riddled with sulphide stringers that consist of pyrrhotite and subordinate pyrite and chalcopyrite. Gold appears to be associated with the sulphides. Assays of up to 1160 ppb Au were obtained from samples taken by the field party.

CONTROLS ON GOLD MINERALIZATION

Controls on gold mineralization in the map area are 1) lithologic, 2) structural, and 3) chemical in nature.

Lithologic Controls

Many gold occurrences in the map area, and in the Geraldton area, are situated along the northern half of the Southern sedimentary unit. This unit extends westward from the map area to Lake Nipigon, and has accounted for 94 percent of the gold production in the Beardmore–Geraldton area (Mason and McConnell 1983).

Structural Controls

Macdonald (1983b, 1984) points out the close relationship between gold deposits and the BBDZ in the Geraldton area. Gold mineralization occurs in structurally prepared rocks which acted as traps for gold-bearing fluids. In the Geraldton area, gold is hosted by iron formation and metamorphosed wacke or arkose, and is present along contacts of intrusive rocks with wackes (Macdonald 1983b).

Vein-type mineralization predominates in the Geraldton area. Widespread, small-scale, asymmetric folds and zones of intense shearing at lithological contacts, played an important role in localizing the veins (Anglin and Franklin 1985).

Within the map area, vein-type gold mineralization occurs within, or in close proximity to, the BBDZ and tends to be situated at lithologic contacts. These veins, which are generally parallel to the east-trending fabric of the host rock, occur as fracture fillings and are strongly deformed (*see* Photo 16). At the MacFarlane and Coniagas occurrences (*see* Figure 14), vein mineralization is localized within zones of asymmetric Z-folding in amphibole schists (*see* Figure 16 and Figure 18).

A laterally extensive horizon of magnetite iron formation occurs within the BBDZ; in northern Coltham Township, where it is cut by quartz veins, it is important in localizing gold mineralization (*see* Photo 18).

Gold-mineralized shear zones occur within clastic sediments; the shears parallel the general trend of the BBDZ. They are commonly developed at lithologic contacts. Good examples are found at Westside Bay of Long Lake where the contacts between albite porphyry and clastic sediments are marked by zones of sericite schist.

In the northern part of the map area, three documented gold showings occur within the BRDZ. They occur along an east-trending line which is on strike with the gold deposits at Hutchison Lake in Fulford Township (Pye et al. 1965; Stott 1984a).

At the western end of the Croll Lake stock, auriferous quartz veins occupy fractures in either narrow shears or dilation zones. These fractures may be ascribed to hydrofracturing of the supracrustal rocks during intrusion of the Croll Lake stock and subsequent infilling by mineralizing fluids.

Macdonald (1983b) describes vein-type mineralization consisting of quartz + feldspar ± chlorite ± tourmaline ± sulphide minerals (pyrite, chalcopyrite, galena) throughout the Croll Lake stock; however, little has been found during the present study to substantiate an economic potential for the intrusion.

Chemical Controls

One occurrence of gold mineralization in magnetite iron formation was examined in northern Coltham Township on the Geraldton Longlac Gold Inc. property. The anomalous gold concentrations are confined to areas of pyrite replacement of magnetite in the iron formation (*see* Figure 20). The pyrite has subsequently been fractured (*see* Photo 18); gold is found along these tiny fractures. This suggests that gold has been introduced as a late-stage mineral that precipitated on the sulphides, rather than having been deposited simultaneously during pyrite formation. This proposed sequence of events is in agreement with observations made by Horwood and Pye (1955) at the Hardrock Mine at Geraldton.

Replacement of magnetite by pyrite from sulphur-rich fluids is an important gold precipitating mechanism (Phillips et al. 1984). At the Hardrock Mine, Macdonald (1984) concluded, on the basis of structural and stratigraphic relations, that gold mineralization in the iron formation is unrelated to sedimentary processes, but results from the replacement of magnetite by sul-

Table 2. Information on properties in the northern Long Lake area on file with the Assessment File Research office, Ontario Geological Survey, Toronto and the Resident Geologist's files on Thunder Bay as of December 31, 1987. Refer to Figure 15 for property locations.

Property Reference Number	Property Holder	AFRO File Number	Year	Commodity Sought	Type of Work
1	Amoco Canada Petroleum Ltd. (1981)	Houck Twp. 14	1981	Au, Ag, Cu, Zn	DD
2	Big Long Lac Gold Mining Co. Ltd.				
3	Brinklow, W.W.				
4	Brugger, P.J.	63, 19	1945		G, GM, EC
		2,6152	1983	Au, Ag, Cu	G
		2,10323	1987		AM, AEM
5	Canadian Nickel Co. Ltd. (1970)	Houck Twp. 12	1970		DD
6	Coulson Exploration Incorporated	Res.[1]	1946	Au	T
		63A.408	1962		G
		Houck Twp. 10	1962	Au, Ag	DD
		Houck Twp. 15	1984	Au	DD
		2,10401	1987		AM, AEM
7	Cowan, M.	2,7743	1984		G, GM
8	Discovery West Corp.	63,101	1946		G, GM
		Res.[1]	1969		T
		2,10036	1987		GM, GEM
		2,10274	1987		AM, AEM
9	Duchene, E.J.	63A.22	1947		G
		Longlac 10	1949-51	Au	DD
		Longlac 14	1972	Au,Ag,Cu,Zn	DD
10	Ferau Resources Inc.	McBean Lake 10	1949-51		DD
		63,112 9	1960		GM, GEM
		McBean Lake 17	1964	Au	DD
		Res.[1]	1970		DD
		63,4211	1982-83	Au	GM, GEM, T
		2,6572	1983-84		GM, GEM
		Res.[1]	1986		T
		Res.[1]	1987		DD
11	Geraldton Longlac Gold Inc.	Res.[1]	1939-40	Au	G, DD, T
		63,1944	1966		GM
		Coltham Twp. 10	1966		DD
		2,7267	1984		GM, GEM
		2,9882	1986		GM, GEM
12	Golden Pond Resources/ Metallgesellschaft Canada Ltd. (1984)	2,7623	1984		GM, GEM
		2,8120	1984		G
13	Hard Rock Gold Mines Ltd. (1951)	63A.22	1947		G
		Longlac 10	1949-51	Au	DD
14	Head, T.S.				
15	Hudson Bay Exploration and Development Co. Ltd. (1973)	Longlac 13	1972-73	Au,Ag,Cu,Zn	DD
		Houck Twp. 13	1972	Au,Ag,Cu,Zn	DD
16	Lafontaine, A.				
17	Malouf, M.	63,1282	1964	Au,Ag,Cu,Zn	G, GM, GEM
		Res.[1]	1972		T
		2,9138	1986		GM, GEM
		2,9260	1986		GM, GEM
18	McLeod-Cockshutt Gold Mines Ltd. (1965)	Res.[1]	1962		DD
		Houck Twp. 11	1965	Au,Ag,Cu,Ni	DD
19	McNicoll, B.J.	2,10323	1987		AM, AEM
20	Mid-North Eng. Services Ltd.	63,1282	1964		GM, GEM
		2,1089	1972		GM, GEM
		2,7988	1984		GEM
		2,9562	1986	Au	GC

Table 2. Continued.

Property Reference Number	Property Holder	AFRO File Number	Year	Commodity Sought	Type of Work
21	Pressman, B.(1962)				
22	Rissanen, A.E.				
23	Roxmark Mines Limited	2,10577	1987		AM, AEM
24	Theriault, O.	Res.[1]	1974		T
		Croll Twp. 10	1982-83		DD
		Croll Twp.11	1984		DD
		Res.[1]	1984		T
25	Wilhelm, H.E.				
	Shell Canada[2] Resources Limited	2,2947	1978		AM
		2,4590	1979		GM
		McBean Lake 18	1980	Au,Ag,Cu,Zn,Ni	DD

[1] *Resident Geologist's office, Thunder Bay*

[2] *From 1978 through 1980, Shell Canada Resources Limited explored on property held in 1987 by Discovery West Corp. and Roxmark Mines Ltd. Results of this work are filed under Shell Canada in the assessment files of the Beardmore–Geraldton Resident Geologist's Office, Thunder Bay.*

Abbreviations:

AEM	Airborne Electromagnetic Survey	GC	Geochemical Soil Sampling
AM	Airborne Magnetic Survey	GEM	Ground Electromagnetic Survey
DD	Diamond Drilling	GM	Ground Magnetic Survey
EC	Electrical Conductivity Survey	T	Stripping, Trenching
G	Geological Survey		

phides and veins cutting iron formation. Macdonald (1984) proposed that iron formation acted as both a conduit and a chemical trap for auriferous solutions.

Origin of Gold Deposits

The source of the gold in the Geraldton area, including the map area, is unknown. The various spatial relationships, and the distribution of gold mineralization, however, provide clues to key factors that probably played a role in the formation of gold deposits.

The Croll Lake stock has been regarded as being a possible source of gold in the Geraldton camp (Horwood and Pye 1955). Later, the possibility that gold deposits at the Geraldton camp were formed by synsedimentary processes was seriously considered (Macdonald 1982) although investigations by Macdonald (1982, 1983a, 1984) provided negative evidence for a syngenetic model. Instead, Macdonald suggested that the BBDZ provided a structurally controlled environment and that the iron formation acted as a chemical trap for gold that was deposited from late-stage fluids.

Macdonald (1983b) does not disregard the possibility that the Croll Lake stock played a role in the gold mineralization at Geraldton. The extensive distribution of gold deposits throughout the entire Beardmore–Geraldton belt suggests that the relation of the Croll Lake stock to significant gold mineralization is unlikely. It is suggested here that mineralization consisting of tourmaline, carbonate, chalcopyrite, molybdenite and gold in quartz veins near Mineral Lake was precipitated from fluids that filled fracture systems which may have developed as the result of the intrusion of the Croll Lake stock.

Within the map area, gold deposits are found along the BBDZ and BRDZ, which probably acted as conduits for the migration of gold-bearing solutions.

SILVER

Silver is commonly recovered as a by-product from the gold ore. The Geraldton camp has produced approximately 240 000 ounces of silver. When compared with the 3 million ounces of gold produced, this gives an average silver to gold ratio of 1:12.5.

Within the map area, a proportional relationship between silver and gold mineralization has not been found, and most assays which returned anomalous gold values had silver contents which were below the detection limit of 2 ppm. Some of the highest silver contents were accompanied low gold values (*see* Table 3).

BASE METALS

The only known base metal occurrence in the map area is the Sopko occurrence in eastern Abrey Township (M. Malouf property), where massive pyrite seams, the largest of which is 30 cm in width, host small patches of sphalerite. The sphalerite patches are a minor constituent of the massive sulphide seams which themselves are of limited extent along strike.

Traces of sphalerite also occur in an auriferous quartz vein in central Oakes Township (E.J. Duchene property).

Chalcopyrite is a common mineral in many sulphide-bearing quartz veins in the map area, especially west of Mineral Lake.

Molybdenite is a trace component of sulphide-bearing veins west of Mineral Lake but is insufficient in quantity to be of economic importance. Molybdenite mineralization occurs on the west side of Burrows Lake, 9 km north of the northwest corner of Houck Township; it is described by Macdonald (1943) and by Johnston (1968). Here, molybdenite occurs as coarse flakes in quartz veins and as disseminated grains in gneissic granite. The deposit was reported to contain possible reserves of 751 400 pounds MoS_2 (Johnston 1968).

IRON

Iron was the first mineral commodity sought in the Beardmore-Geraldton area (Coleman 1909). Petrographic examination indicates that iron formation from the map area consists of approximately equal amounts of magnetite and quartz. These units are not thick enough to form economically viable deposits, despite their extensive length.

MAGNESITE

A rusty weathering, carbonatized peridotite dike cuts porphyritic granite outcrops in a roadcut on Highway 11, approximately 1 km west of Suckle Lake. The dike is composed of about 50 percent magnesite nodules replacing olivine. The continuity of the dike along strike is not known.

STONE

Granitic rocks of the Croll Lake stock are a potential source of building stone, although a weak fabric development throughout a large part of the stock, abundant joint development, and the presence of numerous mafic inclusions, may render the rock unsuitable for some purposes. A small quarry in granitic rock, directly east of Suckle Lake where a Trans-Canada Pipeline access road meets at Highway 11), has been operated by Ontario Hydro.

SAND AND GRAVEL

The sand and gravel potential of the area has been outlined by Gartner (1979). Kame deposits associated with eskers in Houck, Croll and northern Coltham townships are sources of aggregate. These deposits have been used for local road construction.

PEAT

A general peat evaluation of the Longlac-Nakina area, including portions of Houck and Oakes townships, was undertaken for the Ontario Geological Survey by Dendron Resource Surveys Limited in 1984. The peat in the map area was found to be of limited potential. Quality ranges from poor to fair for horticultural peat and fuel peat.

Suggestions for Exploration

The map area adjoins the Geraldton gold camp to the east and is a significant gold prospecting terrain. All parts of the map area are accessible by Highway 11, secondary all-season gravel roads, two lines of the Canadian National Railway and by Long Lake.

Two large deformation zones associated with east-striking regional faults represent favourable targets for gold exploration.

Gold associated with pyritized magnetite iron formation is present in one locality within the map area. The iron formation is poorly exposed in outcrop, although easily traceable by geophysical methods. In the Geraldton area, pyritization of iron formation is an important control of gold mineralization. Extensions of this type of mineralization should be sought in the map area.

Outside the two major deformation zones, gold is found at the western end of the Croll Lake stock at Mineral Lake where it is associated with quartz-tourmaline veins.

Thorleifson and Kristjansson (1987) undertook a study of gold grains in surface tills of the Beardmore-Geraldton area. The data from this study emphasize the need to use overburden exploration methods.

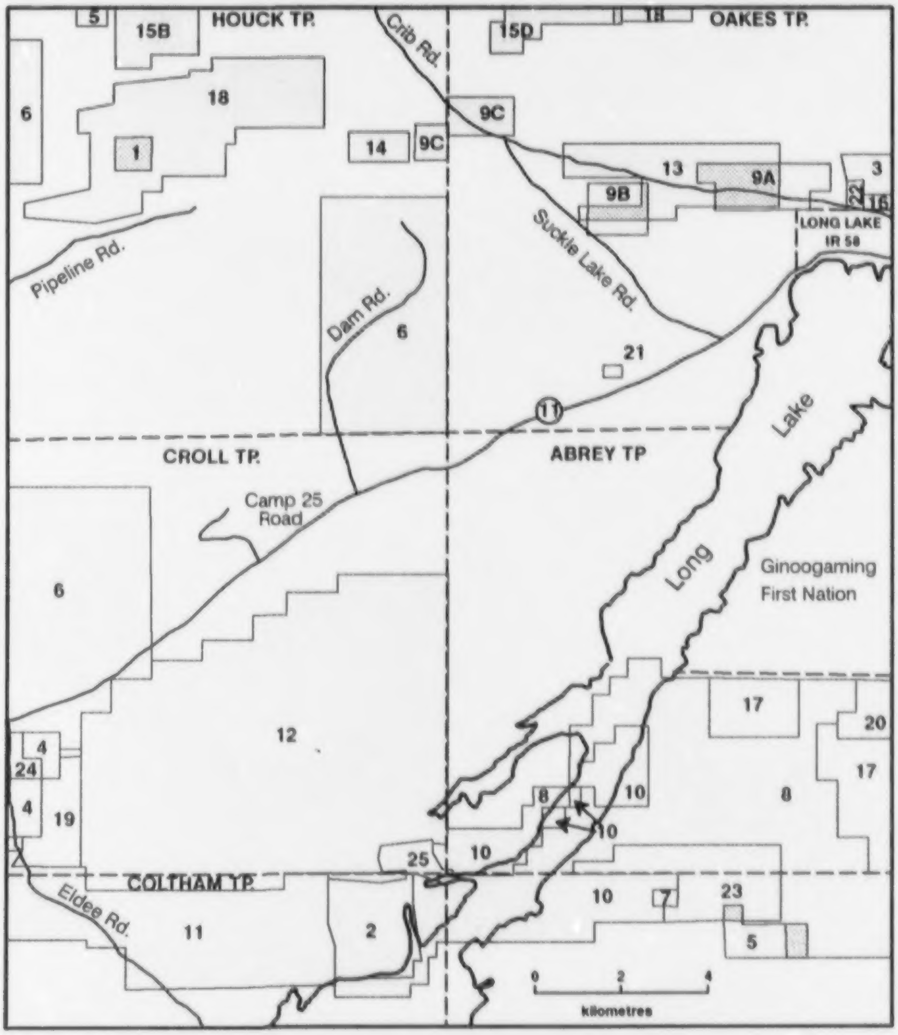
Description of Properties

As of July 9, 1987, 18 companies and individuals held properties in the northern Long Lake area. Parcels of land which have reverted to the Crown prior to July 9, 1987, but for which assessment work is available, are listed alphabetically by the name of the last property holder. The locations of these properties are shown in Figure 15. Table 2 summarizes property ownership as of July 1987.

Information on past and present properties was obtained from company reports filed with the Assessment Files Research Office of the Ontario Geological Survey, assessment and mineral deposits records on file in Resident Geologist's office in Thunder Bay, Ontario Geological Survey reports, newspaper articles and property holders.

Amoco Canada Petroleum Company Limited

In 1981, Amoco Canada Petroleum Company Limited drilled three holes, totalling 1416 feet, in Houck Township approximately 1 km southeast of Alfred Lake. The claims were within a larger claim block explored previously by McLeod-Cockshutt Gold Mines Limited. The drill holes encountered metavolcanic rocks and epiclastic metasedimentary rocks with minor magnetite iron formation containing numerous small quartz vein-


HOUCK TP.
OAKES TP.
CROLL TP.
ABREY TP.
COLTHAM TP.
Crib Rd.
Pipeline Rd.
Dam Rd.
Suckle Lake Rd.
Camp 25 Road
Eldee Rd.
11
Long Lake
LONG LAKE IR 58
Ginoogaming First Nation
5
15B
15D
18
6
1
14
9C
9C
13
9A
9B
3
22
16
21
6
6
12
4
24
4
19
25
10
8
10
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17
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2
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kilometres

Figure 15. Property locations as of July 1987. The plan shows the principal access roads within the map area. Information on properties is listed in Table 2.

lets. Reported mineralization includes pyrite, pyrrhotite and chalcopyrite in small lenses and disseminations. Best reported assays are 0.02 ounce Au per ton, 0.11 ounce Ag per ton, 0.012 percent Cu and 0.11 percent Zn over 5 feet (1.5 m).

Big Long Lac Gold Mining Co. Ltd.

Big Long Lac Gold Mining Co. Ltd. holds 16 patented mining claims, TB10311 to TB10322 and TB10548 to TB10551, in the northeastern corner of Coltham Township.

Active surface exploration on the property took place in 1933 and 1934 with a program of trenching, stripping and test pitting. Operations were suspended in 1934 following a diamond-drilling program totalling 2100 feet. Results from this work were disappointing (*The Northern Miner*, October 25, 1934, p.26). The claims were surveyed in 1941, patented in 1947 (Mason and White 1986) and have remained idle since.

The property is underlain by turbiditic sandstones and conglomerate and thinly laminated magnetite iron formation. East-striking feldspar porphyry dikes with large albite phenocrysts intrude the metasediments. The contacts between the dikes and the metasediments are, in general, highly sheared. Narrow shears are found on the property at Westside Bay within metasedimentary rocks, and along the contacts between feldspar porphyry dikes and metasedimentary rocks. The shears are mineralized with disseminated pyrite, pyrrhotite and chalcopyrite. Fairbairn (1938) reported "coarse visible gold" in a 2-inch shear from an unspecified locality on the property. A grab sample taken by the field party from a 1 m wide pyrrhotite- and pyrite-mineralized shear on the west side of Westside Bay assayed 35 ppb Au.

Trenching carried out by Big Long Lac Gold Mining Co. Ltd. uncovered eight quartz-carbonate veins mineralized with minor pyrite, on the property. These range in width from 2.5 cm to 3.7 m; gold assays up to 0.74 ounce per ton were reported (*The Northern Miner*, July 20, 1933, p.5). The veins strike approximately 080° and are hosted by sericite schist. Grab samples, obtained by the field party from two separate veins, returned values of 35 ppb and 3 ppb Au.

Brinklow, W.W.

In 1987, William and Rachel Brinklow held eight unsurveyed claims north of Long Lake Indian Reserve No. 58 in eastern Oakes Township. Visible gold was found in several quartz veins by the claim owners. There is no record of previous work on this property.

The property is underlain by strongly deformed, recrystallized, mafic pillow basalt with interflow units of intermediate to felsic volcaniclastic rocks and minor quartzofeldspathic sedimentary rocks, and minor gabbro.

Milky white quartz veins, exposed by test pitting, ranging from 5 to 20 cm in width and of undetermined length, occur in amygdaloidal basalt. Some of the quartz veins are mineralized with pyrite and contain visible gold. Two samples of vein material taken by the field party returned assay values of 1680 ppb and 5770 ppb Au respectively. A small unit of sugary quartz, probably a recrystallized interflow chert horizon in fragmental metavolcanics, forms a small outcrop. This cherty unit is mineralized with abundant pyrrhotite and lesser pyrite and chalcopyrite. Two mineralized samples from this chert assayed 33 ppb and 1160 ppb Au respectively.

Brugger, P.J.

The P.J. Brugger property consists of two claim blocks, totalling 44 unsurveyed claims, in Croll Township near Mineral Lake. The claim group extends into Ashmore Township.

The earliest record of work on a portion of the property was by Mat-a-lac Gold Mines Limited in 1936, who conducted some stripping and trenching (Mason and White 1986).

In 1945, Draco Mines Limited conducted geological, magnetic and electromagnetic (EM) surveys over a group of 57 claims centred on the common corners of Croll, Coltham, Ashmore and McKelvie townships, covering the southern portion of the present Brugger claims.

There is no further record of work on the property until 1983 when Cambridge Resources Ltd. carried out a geological survey over a 40-claim group in Croll and Ashmore townships, including a portion of the present Brugger claims.

In 1987, airborne magnetic and EM surveys were carried out on behalf of Paul Brugger by H. Ferderber Geophysics Limited. The surveys outlined 14 small conductors.

The property, in Croll Township, is underlain by weakly carbonatized and silicified, amygdaloidal, massive to pillowed basalt and gabbro intruded by feldspar and quartz porphyry dikes. Quartz-tourmaline veins are common. Several unrecorded pits and trenches in pyrite-bearing feldspar porphyry and carbonatized basalt were located during the present survey in the southern part of the property.

Canadian Nickel Co. Ltd.

Between 1970 and 1972, Canadian Nickel Co. Ltd. conducted a drilling program in Houck Township, in McQuesten Township (west of the map area), in Bickle Township and in the Alfred Lake area (north of the map area). In addition, the company drilled several holes in the McBean Lake area, south of Abrey Township. One 125.6 m drill hole on Alfred Lake, in northern Houck Township, encountered stringers and disseminations of pyrrhotite, pyrite and traces of chalcopyrite in intermediate metavolcanic rocks. No further work on the Houck Township claims was reported and the claims were allowed to lapse.

Coulson Exploration Inc.

The land holdings of Coulson Exploration Inc. consist of three, contiguous, unsurveyed claim groups, here referred to as the Dam occurrence claims, in eastern Houck Township; the Forrester Lake claims in western Croll Township; and the Alfred Lake claims in western Houck Township.

DAM OCCURRENCE CLAIMS

Exploration History

In 1961, a gold-bearing quartz vein was discovered by the Ontario Department of Public Works during the construction of a flood control dam on the Kenogamisis River in the eastern part of Houck Township; it became known as the Dam occurrence (Mason and White 1986).

In 1962, geological mapping, and subsequent diamond drilling of eight holes totalling 308 m, were completed by Scope Mining and Exploration Consultants Limited in the vicinity of the discovery site. No further work was carried out until 1984, when Thorwald Johansen diamond drilled one vertical hole to a depth of 30.6 m on the south shore of the Kenogamisis River upstream from the dam. The hole encountered mafic metavolcanic rocks with minor pyrite, pyrrhotite, sphalerite and chalcopyrite mineralization.

In the early summer of 1987, a program of airborne magnetic and electromagnetic surveying, geological mapping and prospecting was conducted for Coulson Exploration Inc. around the Dam occurrence, over a group of 91 claims. No further significant discoveries were made.

Geology and Mineralization

Bedrock exposure on the claim group is scarce and is mainly confined to an area along the Kenogamisis River and south of Octopus Lake. The principal rock types are strongly deformed mafic pillowed flows intruded by feldspar porphyry dikes, with turbiditic quartzofeldspathic sandstone common south of the Kenogamisis River.

The Dam occurrence underlies the bed of the Kenogamisis River directly northeast of the dam and was not examined by the field party due to high water levels. The occurrence is described by Parliament (1962):

> The quartz vein in the river bed is reported to be from 3 to 8 inches wide within a shear zone up to 10 feet wide in places with considerable sulphide mineralization. The strike of the vein is about N55°E and dip 80°S. Samples from the vein show drag folding and are well mineralized with pyrite, pyrrhotite, arsenopyrite and traces of chalcopyrite. The vein was reported to be the widest near the north coffer dam and open at both ends. A grab sample from the vein assayed 3.89 ounces gold per ton (as reported by N.A. West and A. Newhouse, the original stakers of the property).

Mason and White (1986) obtained a gold assay of 0.44 ounce per ton from a sample of drill core showing silicification and quartz mineralization with pyrite, sphalerite and pyrrhotite.

Narrow, white, quartz veins were observed on the north side of the Kenogamisis River near the dam during the present survey.

FORRESTER LAKE CLAIMS

The Forrester Lake property consists of 105 contiguous unsurveyed claims in Croll Township and 38 claims in Ashmore Township. (The Croll Township claims were held by R. Noel, I. Tremblay, J.P. Baily and D. Vandal in July 1987.)

Exploration History

Original recorded work, in the southern part of the claim group, was by Langmuir Long Lac Gold Mines Limited which, in 1934, exposed a quartz-tourmaline vein near Forrester Lake. The vein is reported to have been mineralized with chalcopyrite, pyrite, traces of native copper and some gold (Bruce 1935). In 1936, the former Langmuir Long Lac Gold Mines Limited ground was held by Maralgo Mines Limited but no work was reported (Fairbairn 1938).

In 1936, Indian Head Long Lac Mines Limited uncovered some quartz veins on an 18-claim group in the central part of the present Forrester Lake claim group, during a program that consisted of 3013 feet of trenching (*The Northern Miner*, November 5, 1936, p.9). Some earlier exploration work on these claims was done by the Superior Long Lac Syndicate (*The Northern Miner*, October 8, 1936, p.5).

Also in 1936, Garnet Long Lac Mines Limited uncovered several irregular quartz-tourmaline veins, mineralized with arsenopyrite and pyrite, on the north side of Kenogamisis Lake (Fairbairn 1938). No further work was reported.

Most activity since 1936 has been concentrated on the southern part of the property. In 1945 and 1946, C.G. Walterson and A. Brisebois staked 16 claims centered on Forrester Lake. Stripping, trenching and some diamond drilling were performed (Horwood and Pye 1955).

Claims covering occurrences in the southern part of the property were staked many times between 1952 and 1984, having been held the longest by J. Wodian and H. Holm. Exploration work, summarized by Mason and White (1986), included trenching, stripping and some diamond drilling.

In 1987, airborne magnetic and electromagnetic surveys were conducted for Coulson Exploration Inc. by Terraquest Limited along with a ground prospecting program over the entire property.

Geology and Mineralization

The claim group is underlain in the north and south parts by amygdaloidal, massive to pillowed basalts and gabbros. The central portion of the claim group is underlain by turbiditic sediments. Outcrop exposure is poor.

Near vertical, white, irregular quartz veins trending generally to the northeast are found in basalt and gabbro east of Forrester Lake. These quartz veins are up to 50 cm wide and are traceable along strike in old trenches for up to 150 m. The veins are locally mineralized with sulphide blebs comprising chalcopyrite, pyrrhotite and pyrite. Two grab samples of sulphide-bearing quartz from two veins yielded 30 ppb and 200 ppb Au respectively.

A series of unrecorded pits and north-trending trenches were located by the field party, about 1 km north of Forrester Lake. Some limonite-stained quartz-vein material containing disseminated pyrite was found. Grab samples of pyrite-mineralized vein material from the trenches did not return any anomalous gold values; one sample assayed 34 ppm silver.

ALFRED LAKE CLAIMS

The Alfred Lake property consists of 16 unsurveyed claims centred on Alfred Lake (and held by R.O. Jolly). These claims are part of an extensive claim holding extending westward into McQuesten and Fulford townships.

In Houck Township, the property is underlain by turbiditic sandstones and mafic metavolcanic rocks. Bedrock exposure is poor.

COWAN, M.

The M. Cowan property consists of two adjoining unsurveyed claims located in the McBean Lake area, south of Abrey Township.

In 1984, M. Cowan conducted ground magnetic and geological surveys over the claims. Magnetic anomalies were located on the property.

Underlying rock types are upper greenschist- to amphibolite-grade, mafic metavolcanic rocks, and quartzofeldspathic and immature sedimentary rocks metamorphosed to hornblende schists.

DISCOVERY WEST CORP.

In 1987, Discovery West Corp. held 150 unsurveyed claims in and south of Abrey Township.

The earliest record of work on the property was by Independent Mining Corporation in 1946, which conducted geological and ground magnetic surveys at and south of Skinner Lake. Paikin (1946) reported evidence of earlier stripping and trenching in the area.

In 1969, O. Albert carried out trenching and stripping on one claim north of Milbean Lake.

In March 1987, an airborne magnetic and electromagnetic survey was flown over the property for Discovery West Corp. by Aerodat Limited. The survey outlined the presence of iron formation and a number of electromagnetic anomalies. Follow up work by Discovery West Corp. consisted of ground magnetic and electromagnetic surveys over a number of targets.

The property is underlain principally by mafic metavolcanic rocks and associated gabbro intrusions in the north, and immature sediments recrystallized to hornblende schists, quartzofeldspathic sandstone and magnetite iron formation in the south. An elliptical quartz-feldspar porphyry body, approximately 2 km by 1.5 km, is exposed in the southern part of the claim group.

A grab sample from a pyrite-bearing, garnet-biotite schist, approximately 2 km southwest of Skinner Lake, assayed 31 ppb Au.

DUCHENE, E.J.

In 1987, E.J. Duchene held 39 unsurveyed claims in three blocks in the map area; these are referred to here as claim groups A, B and C on Figure 15.

Claim Group A

Claim group A consists of 18 contiguous claims directly northwest of Long Lake Indian Reserve No. 58 in Oakes Township. Unrecorded pits and trenches were located on the property by the field party. This property was originally explored by Hard Rock Gold Mines Limited in 1947.

The claim group is underlain by strongly deformed mafic metavolcanic rocks, coarse fragmental, metavolcanic rocks and gabbro.

A 10 cm wide, vertical quartz vein, striking 080°, has been traced for 20 m in schistose metavolcanic rocks. The vein is located approximately 1.5 km northwest of the northwest corner of Long Lake Indian Reserve No. 58. The vein material carries minor pyrite, chalcopyrite and sphalerite. A grab sample from this vein assayed 830 ppb Au. Approximately 700 m south of the quartz vein, small rusty shears have been exposed in trenches along the contact of mafic metavolcanic rocks with granite of the Croll Lake stock. No anomalous gold values were obtained from this location.

Claim Group B

Group B is a block of nine contiguous claims in central Oakes Township. The property is underlain by strongly deformed, mafic, pillowed metavolcanic rocks. Outcrop exposure is poor.

Claim Group C

Group C comprises 12 claims straddling the boundary of Houck and Oakes townships.

South of Noel Lake, in Oakes Township, several rusty shears up to 10 m wide, are present in pillow basalt. The rusty appearance is imparted by fine-grained disseminated pyrrhotite, pyrite and chalcopyrite. The shears are carbonatized; they host quartz veins up to 20 cm wide which parallel the east-trending shears. A few quartz veins contain minor chalcopyrite and pyrite. One grab sample of quartz-vein material taken by the field party assayed 80 ppb Au. A grab sample from a pyrite seam in one 10 m wide shear, assayed 40 ppb Au.

FERAU RESOURCES INC.

The Ferau Resources Inc. property comprises 87 unsurveyed claims in Coltham, Croll and Abrey townships, and the McBean Lake area south of Abrey Township. The claims were staked by M. Malouf. The present property encompasses the Long Lac Adair and West-Side Long Lac gold occurrences on the west side of Long Lake, and the MacFarlane, Coniagas and Smith Elliot gold occurrences on the east side of Long Lake (*see* Figure 14).

West-Side Long Lac Occurrence

In 1934, West-Side Long Lac Gold Mines Limited carried out a trenching program on two discrete shears, here referred to as the West-Side Long Lac occurrence, on the east side of Westside Bay of Long Lake (*see* Figure 14). Diamond drilling of nine holes, totalling 2000 feet, was completed on the two shears in 1936 (*The Northern Miner*, October 15, 1936, p.31). Some low gold values were reported. The rocks in the old workings have since been overgrown by vegetation; the following description of the geology has been excerpted from Fairbairn (1938).

> The north [shear] zone is traced for 800 feet east from the shore of the bay on a strike of N75°E. The western 200 feet close to the shore is well exposed, has a maximum width of 20 feet and lies in banded iron formation. A feldspar-quartz porphyry dike, ranging in thickness from 1 to 12 feet, is associated with the shear zone. Quartz stringers and sheared lens-like veinlets carry a considerable amount of pyrite. The pyrite is particularly abundant where the zone intersects iron-rich layers of the country rock. There is no visible gold. The south shear zone lies in porphyritized boulder conglomerate immediately north of a coarse white feldspar porphyry. It is 40 feet wide in the main trench; 250 feet distant its width averages about 1 foot. Small stringers and lenses of quartz carry pyrite over a zone whose maximum width is 20 feet. No visible gold has been reported. Fine arsenopyrite is disseminated throughout the showing and galena occurs with calcite in minor amounts.

During the present survey, quartz-carbonate vein material, in sericite schist, but barren of sulphides, presumably from the north shear zone, was sampled; it returned 9 ppb Au. Two samples of quartz with disseminated pyrite, presumably from the south shear zone, also collected from old trenches in sericite schist; these returned assay values of 11 and 15 ppb Au respectively. The sericite schist occurs at the contact between conglomerate and albite porphyry.

The most recently recorded work over the occurrence included magnetic and electromagnetic surveys, in 1983 and 1984, by M. Malouf. The magnetic survey delineated the distribution of iron formation south of Birch Bay.

Long Lac Adair Occurrence

Long Lac Adair Mines Limited engaged in a trenching program on a mineralized shear south of Birch Bay, in 1934 (*see* Figure 14). The work did not disclose "a workable deposit" (Fairbairn 1938).

Fine-grained disseminated chalcopyrite and pyrite were observed during the present field work, in a small, boudinaged quartz-calcite vein hosted by chlorite-sericite schist which is exposed in an old trench. An assay of a grab sample of vein material returned no anomalous gold value.

A pyrite-mineralized quartz vein, 1.5 km north of the Long Lac Adair occurrence, was drilled by McNeil Long Lac Gold Mines Limited in 1936. Results were reported as discouraging (Fairbairn 1938). In 1939, the Wakami Gold Mining Syndicate Limited diamond drilled the same vein (*The Northern Miner*, March 30, 1939, p.7). No further work on this vein was recorded.

MacFarlane West Occurrence

A surface exploration program, which included the sinking of a 30-foot timbered shaft (Mason and White 1986), over the MacFarlane West occurrence (*see* Figure 14), was carried out by MacFarlane Long Lac Gold Mines Limited in 1934.

In 1950 and 1951, J. Pichette drilled four holes, totalling 315 feet, in the vicinity of the MacFarlane West occurrence.

In 1984, M. Malouf carried out a ground magnetic and electromagnetic survey over the occurrence.

The geology of the MacFarlane West occurrence, has been described by Fairbairn (1938) as follows:

> Two coarse white feldspar porphyry dikes, 2 feet and 4 feet wide, separated by 5 feet of altered metasedimentary material are exposed at the MacFarlane West occurrence. The feldspar in the dikes is albite-oligoclase. The dikes are enclosed by sheared boulder conglomerate, which strikes N75°E, dips 80°N and pitches 35°W. Coarse visible gold is reported from the porphyry contact.

A 0.3 m wide shear, characterized by sericite schist, striking 270° and dipping 85°N, is exposed several metres to the east of the shaft on the MacFarlane West occurrence. The sericite schist carries approximately 10 percent fine-grained pyrite and arsenopyrite. A grab sample of sulphide-rich material returned 190 ppb Au upon assay. Some irregular quartz-tourmaline veins occur in a feldspar porphyry dike approximately 20 m east of the shaft, although no metallic mineralization was observed.

MacFarlane East Occurrence

Between 1936 and 1938, MacFarlane Long Lac Gold Mines Limited explored the MacFarlane East occurrence (*see* Figure 14) with the completion of 15 000 feet of diamond drilling and the sinking of a 147-foot timbered shaft including 80 feet of drifting (*The Northern Miner*, November 3, 1938, p.4). In 1938, the company changed its name to MacFarlane Consolidated Mines Limited and little further work was done except for a geological survey in 1946 (*The Northern Miner*, May 13, 1948).

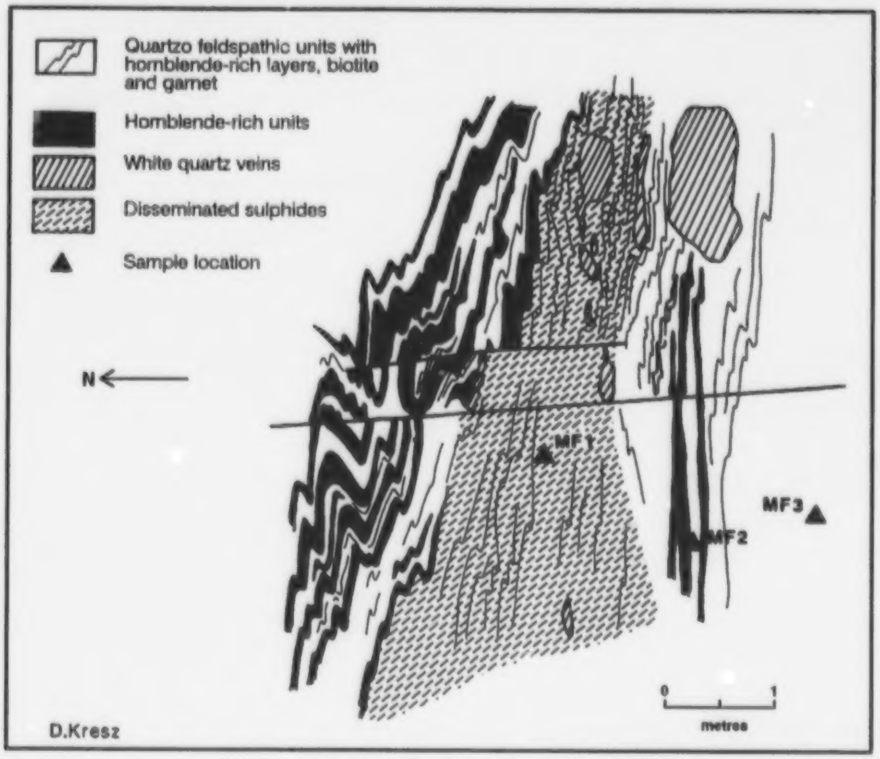

Figure 16. Field drawing of exposed bedrock in an overburden stripped area at the McFarlane East occurrence. The drawing shows a folded structure in quartzofeldspathic and hornblende-bearing schist, and features pertaining to gold mineralization. Sulphide species identified under the microscope using reflected light, include pyrrhotite, pyrite, chalcopyrite and arsenopyrite. Sample MF1 returned a gold value of 5280 ppb.

In 1949 and 1950, J. Pichette drilled four holes, totalling 355 feet, in the vicinity of the occurrence.

The most recent activities on the occurrence included an extensive surface stripping and diamond-drilling program by Ferau Resources Inc., in progress during the summer of 1987.

The underlying rocks at the MacFarlane East occurrence are fine-grained interlayered quartzofeldspathic and immature sediments, recrystallized to hornblende schist which commonly shows asymmetric Z-shaped folds (Figure 16). Small garnet crystals, up to 0.5 cm across, are abundant. Zones of finely disseminated sulphides, such as pyrrhotite, chalcopyrite, arsenopyrite and pyrite, impart a rusty appearance to the outcrops. Two grab samples of sulphide mineralized metasediments from this occurrence assayed 700 ppb and 5280 ppb Au respectively.

Coniagas West Occurrence

This occurrence (*see* Figure 14) was trenched and sampled by Coniagas Mines Limited in 1936.

Most recent activity on the occurrence included trenching and diamond drilling by Ferau Resources Inc., in 1987.

The geology of the Coniagas West occurrence is very similar to the MacFarlane East occurrence, being predominantly garnetiferous hornblende schists representing recrystallized immature sediments with lesser quartzofeldspathic sediments. Narrow, silicified, east-trending shears, up to 0.3 m wide and showing asymmetric Z-folds, are present (Figure 17).

Gold is associated with a pyrrhotite- and arsenopyrite-mineralized (*see* Photo 19) east-trending shear which hosts irregular quartz veins traceable for 2 m in a trench. Eldorado Nuclear Limited sampled trenches at this occurrence in 1982 and obtained a maximum gold assay of 0.106 ounce per ton over 10 feet (Archibald 1983). A grab sample of sulphide-mineralized, sheared rock taken by the field party, gave an assay value of 35 ppm Au.

Coniagas East Occurrence

Outcrop exposure at the Coniagas East occurrence (*see* Figure 14) has recently been enlarged following overburden stripping by Ferau Resources Inc., and is shown on Figure 18. The geology and mineralization is very similar to the Coniagas West occurrence, described above. A grab sample of hornblende schist with some sulphide mineralization and quartz, from an east-trending shear, gave an assay value of 80 ppb Au.

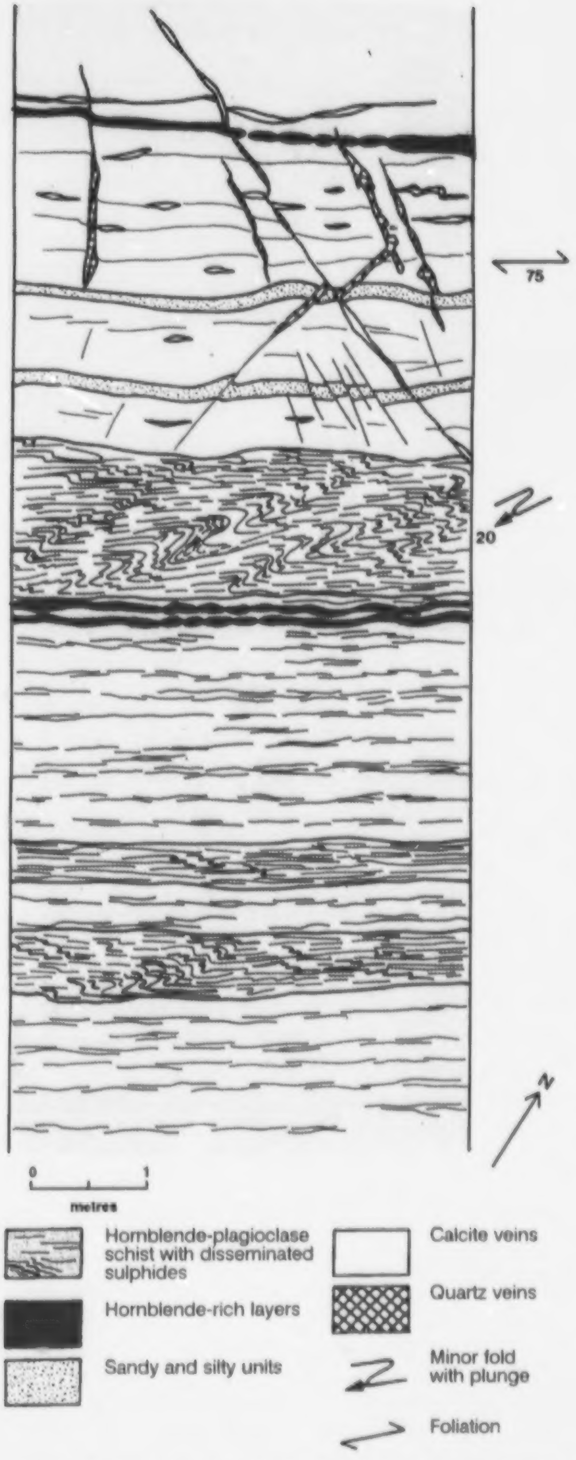

Figure 17. Field drawing of bedrock exposure in an overburden trench located approximately halfway between the McFarlane East and the Coniagas West showings. The drawing shows the various structures (folds, boudinaged layering, minor faults and mineral filled fractures) found in hornblende schist and quartzofeldspathic sandstone.

In 1970, the Canadian Nickel Co. Ltd. drilled two holes, totalling 298 feet, south of a small pond 1 km southeast of the Coniagas East showing. Some disseminated pyrite and pyrrhotite were encountered in drill core.

Smith–Elliot Occurrence

Irregular quartz-tourmaline veins, occurring in outcrops of sheared quartz porphyry on the east side of Long Lake, constitute the Smith–Elliot occurrence (*see* Figure 14). During the present survey, a sample from a quartz-tourmaline vein, barren of sulphide mineralization, returned an assay value of 7 ppb Au.

In 1961, Rambler Exploration Company Limited conducted a ground magnetic survey and carried out some trenching and sampling over the occurrence. The best gold assay obtained by the company was 0.97 ounce per ton over a 2-foot width; it is presumed that samples are from the mineralized location described by Fairbairn (1938) in which pyrite, arsenopyrite and visible gold were reported.

Winchester Exploration Limited drilled six holes, totalling 1101 feet, on the occurrence in 1964. The results were discouraging and no further work took place.

Geraldton Longlac Gold Inc.

M. Malouf held 87 unsurveyed claims in Coltham and Croll townships for Geraldton Longlac Gold Inc. in 1987. The property covers the Burroughs Syndicate occurrence (Mason and White 1986).

EXPLORATION HISTORY

Gold mineralization in north-central Coltham Township was originally investigated by the Burroughs Syndicate between 1934 and 1939, using trenching and surface prospecting (Mason and White 1986). In 1939, a magnetic survey was completed over the property, followed by geological mapping and diamond drilling. Six gold occurrences were located on the property (Sirola 1940). No further follow-up work was done and the claims were cancelled.

In 1934, Trafalgar Long Lake Gold Mines Limited carried out some test pitting and trenching, at the western end of the present property adjoining the Big Long Lac Gold Mines Limited property (*The Northern Miner*, August 16, 1934, p.5).

In 1966, Algoma Ore Properties drilled a 238-foot hole in the northwestern corner of Coltham Township, east of a small pond. Nothing of interest was found.

Much of the present property was staked in 1983 by the Quaternary Mining and Exploration Company Limited, who later transferred the claims to Geraldton Longlac Gold Inc. In 1984, ground magnetic and electromagnetic surveys were conducted over the property. The magnetic survey traced two east-striking iron formation horizons across the property. The electromagnetic survey disclosed several strong conductors. In 1987, diamond drilling was undertaken, along with ex-

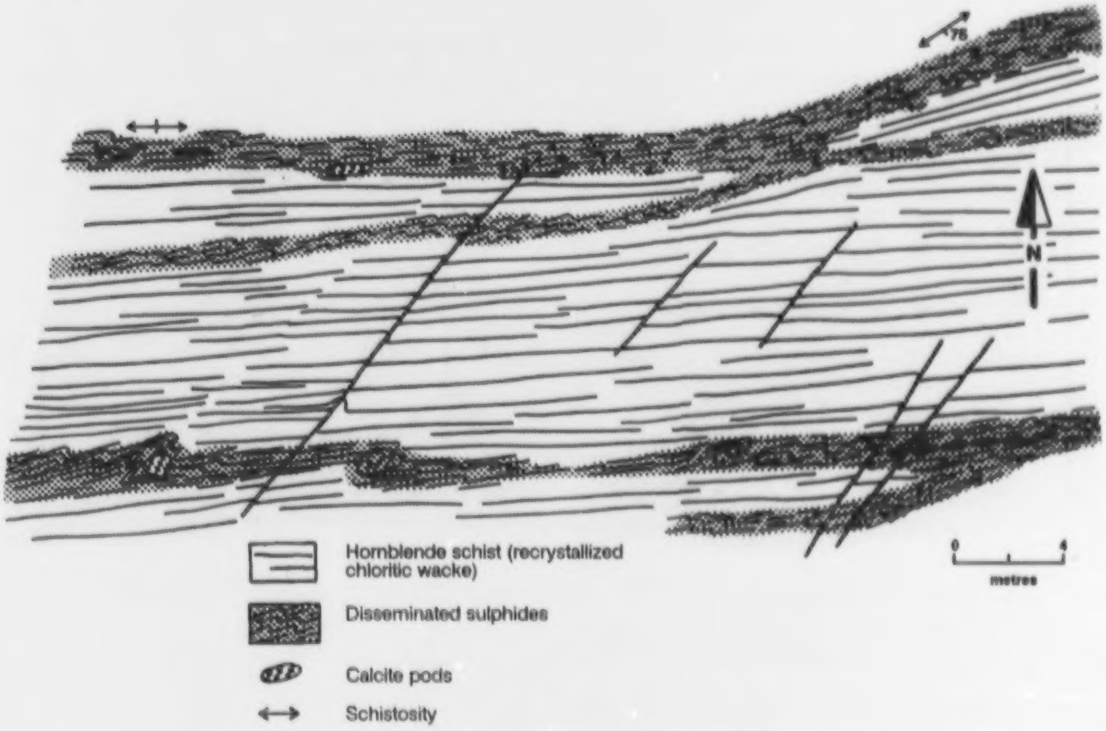

Figure 18. Field drawing of bedrock in an area stripped of overburden at the Coniagas East occurrence. The distribution and shape of zones of disseminated suphides in hornblende schist are shown.

tensive overburden stripping. The results of this latest activity were not available at the time of writing.

GEOLOGY

Bedrock exposure is scarce. As indicated in trenches stripped of overburden by Geraldton Longlac Gold Inc. (*see* Figure 6, Figure 7 (back pocket), Figure 19), the property is underlain by epiclastic sediments of turbiditic facies, including quartzofeldspathic arenite, chloritic siltstone, wacke, pebbly sandstone, conglomerate and magnetite iron formation, coarse-grained pyroxenite, feldspar porphyry and quartz-tourmaline veins. The property straddles the BBDZ, and, as a consequence, the rocks are highly strained in many places; some rock types, such as the massive quartzofeldspathic arenites, feldspar porphyry and pyroxenite have remained relatively undeformed (*see* Photo 5, Photo 7, Photo 13, Photo 14). Intervening, less competent rocks, such as conglomerate, lithic wacke, fine-grained clastic sediments and iron formation as are highly sheared, as are the lithologic contacts (*see* Photo 7, Photo 10, Photo 16; Figure 10, Figure 11).

MINERALIZATION

Sulphide mineralization and some gold is present in two main trenched areas (*see* Figure 7 (back pocket)) on the property, referred to here as the west and east trenches.

West Trenches

Gold-bearing sulphide mineralization is exposed in the southeastern part of the west trenches (*see* Figure 19, Figure 20). Systems of quartz and quartz-carbonate veins, occurring over a 10 m width, are hosted by chloritic, immature clastic sediments and iron formation. Abundant pyrite occurs at the contact between quartz veins and iron formation (*see* Figure 20). The pyritized iron formation is characterized by masses of fractured pyrite cubes, with individual crystals up to 5 mm across (*see* Photo 18). Grab samples of strongly pyritized iron formation gave assay values of up to 41.7 ppm Au, with corresponding low Ag values (*see* Table 3). In contrast, a grab sample of vein quartz with no visible sulphide minerals returned values of 23 ppb Au and 53 ppm Ag.

An overburden trench, directly southwest of the trenches shown in Figure 19, exposes sheared and carbonatized conglomerate. One metre wide, east-trending zones of pyrite-bearing sericite schist occur in the conglomerate. A grab sample of the schistose material gave an assay value of 80 ppb Au.

East Trenches

A group of eight trenches has been excavated in thin till exposing the underlying bedrock. A detailed geological map of the trenched area (Figure 7 (back pocket)) shows the rock types, structures, and sample locations with Au

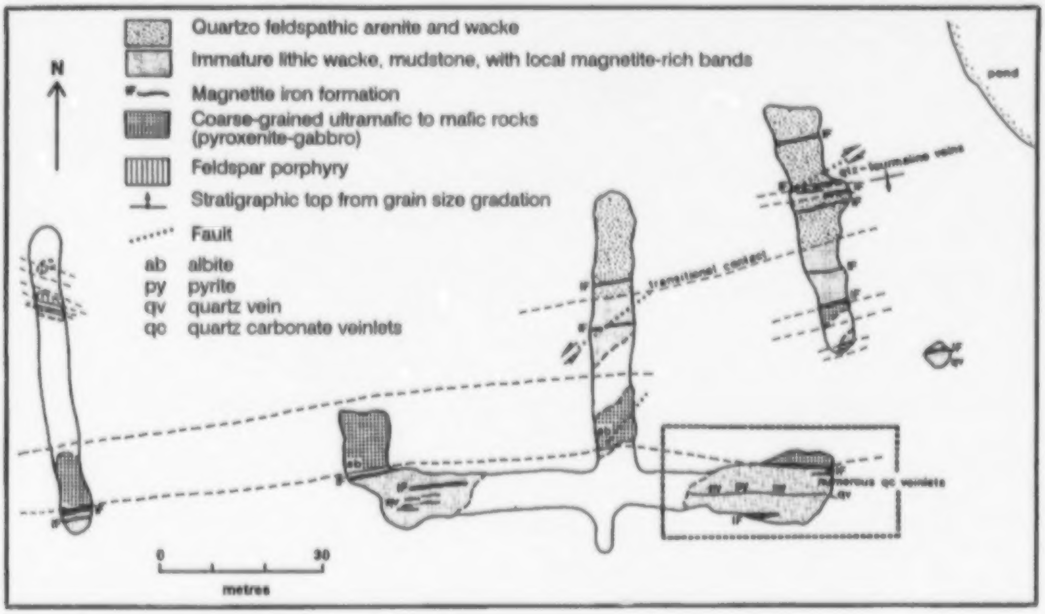
Quartzo feldspathic arenite and wacke
Immature lithic wacke, mudstone, with local magnetite-rich bands
Magnetite iron formation
Coarse-grained ultramafic to mafic rocks (pyroxenite-gabbro)
Feldspar porphyry
Stratigraphic top from grain size gradation
Fault
ab albite
py pyrite
qv quartz vein
qc quartz carbonate veinlets
N
pond
qtz-tourmaline veins
transitional contact
numerous qc veinlets
qv
0
30
metres

Figure 19. Geological sketch map of the western group of trenches on the Geraldton Longlac Gold Inc. property. The relative position, size and shape of the trenches is approximate. The boxed outcrop is shown enlarged in Figure 20.

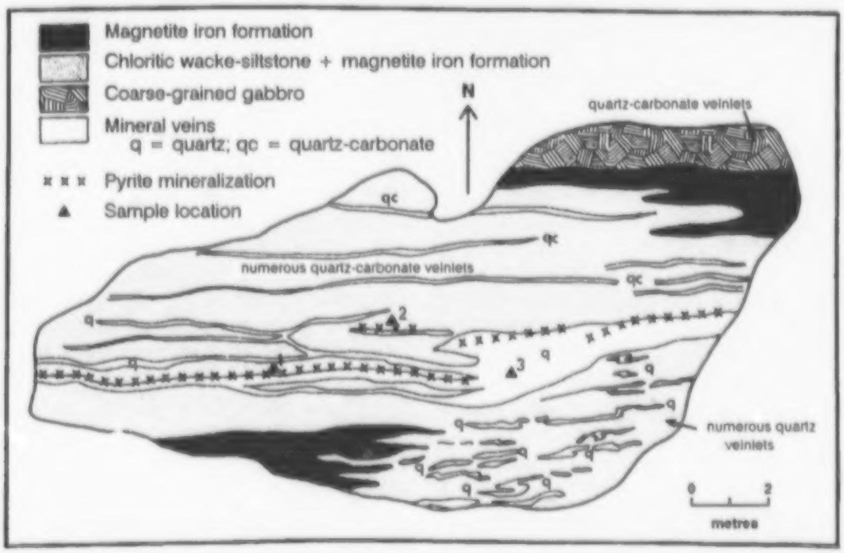
Magnetite iron formation
Chloritic wacke-siltstone + magnetite iron formation
Coarse-grained gabbro
Mineral veins
q = quartz; qc = quartz-carbonate
Pyrite mineralization
Sample location
N
quartz-carbonate veinlets
qc
numerous quartz-carbonate veinlets
q
2
1
3
numerous quartz veinlets
0
2
metres

Figure 20. Enlargment of area depicted in Figure 19, showing the various features associated with the quartz vein system seen on Photo 16.

and Ag assay values. A simplified version of the geology is also shown in Figure 6. The trenches are underlain by thick-bedded, coarse-grained quartzofeldspathic arenite, graded wacke, siltstone, and chloritic mudstone and conglomerate, the latter being highly sheared. Magnetite iron formation bands, which vary in thickness along strike, are intercalated with the sandstones (*see* Photo 10, Photo 12).

Coarse-grained, cumulate-textured, mafic to ultramafic rocks occur in trenches 1, 2, 5, 6 and 8 (*see* Figure 7 (back pocket)). In trenches 1, 6 and 8, the rock is a dark green massive pyroxenite (*see* Photo 13) with gabbro at the margins. In trenches 2 and 5, the rock is coarse- to very coarse-grained with large pseudomorphed pyroxene crystals set in a finer-grained plagioclase-rich matrix that shows a distinct layering (*see* Figure 12). Feldspar

Table 3. Analyses of grab samples from the Geraldton Longlac Gold Inc. property west trenches. Sample locations are shown on Figure 20.

Sample Number	Field Number	Description of Sample	Au	Ag (ppm)
1	1232	magnetite iron formation with pyrite	10.51 ppm	4
2	1233	chloritic siltstone and magnetite iron formation with pyrite	41.7 ppm	6
3	1234	vein quartz, no sulphides	23 ppb	53

porphyry with sparsely distributed mafic clots is present in several places.

Shearing took place mostly at lithological contacts and within fine-grained clastic sediments, conglomerate and iron formation. Well-defined structures that illustrate the various deformation styles within the BBDZ are shown in Figure 10, Figure 11, Figure 12, Photo 6, Photo 10 and Photo 12.

Little mineralization of economic consequence has been encountered in the trenches. Small quantities of sulphides, mainly pyrite, are present in discrete shear zones, and in iron formation where pyrite occurs as cubes up to several millimetres across. Platy crystals of specular hematite have been found within alteration zones at the south end of trench 1. Quartz-tourmaline veins occur in several trenches.

Slightly anomalous gold values have been obtained from trench 5 (*see* Figure 7 (back pocket)), where a sample of a narrow magnetite band containing pyrite cubes gave assay values of 35 ppb Au and 80 ppm Ag. In trench 3 (*see* Figure 7 (back pocket)), a sample from a quartz-tourmaline vein returned 13 ppb Au upon assay.

Auriferous Quartz Boulders

Two erratic quartz boulders, the largest of which is 1.5 m across, were located by the field party along a tractor trail in northern Coltham Township, approximately 1.5 km southwest of the west trenches. The white quartz is riddled by very narrow, secondary glassy quartz veinlets and contains sparsely disseminated pyrite. The source of the boulders is unknown. A grab sample of one boulder gave an assay value of 470 ppb Au.

Golden Pond Resources Limited/Metallgesellschaft Canada Limited

A block of 291 contiguous claims, covering the southeastern portion of Croll Township, was investigated in 1984 in a joint venture between Golden Pond Resources Limited and Metallgesellschaft Canada Limited. The exploration program consisted of ground magnetic and geological surveys. Nothing of economic importance was located and the property has since reverted to the Crown.

Most of the property is underlain by biotite granodiorite of the Croll Lake stock. Massive, mafic metavolcanic rocks occur in the southeast part of the property.

Hard Rock Gold Mines Limited

From 1947 to 1951, Hard Rock Gold Mines Limited investigated several mineral occurrences on a block of 45 contiguous claims in central Oakes Township. In 1947, a geological survey was completed over the property. Between 1949 and 1951, a diamond-drilling program of 14 holes, totalling 868 feet, was conducted.

The property is underlain by massive and pillowed mafic flows, intermediate lapilli tuff and tuff breccia, gabbro, and in the southern section, by granitic rocks of the Croll Lake stock.

An area of gold mineralization, 1.5 km northwest of Long Lake Indian Reserve No. 77, was held by E.J. Duchene in 1987.

Head, T.S.

In 1987, T.S. Head held six contiguous unsurveyed claims northeast of Robert Lake in Houck Township.

The property is underlain by strongly deformed, amygdaloidal mafic metavolcanic rocks and silicified chlorite schist. Several carbonatized shears, approximately 1 m wide and striking 070°, carry two to five percent fine-grained pyrite. A grab sample of pyrite-bearing rock gave an assay value of 13 ppb Au. Several barren quartz veins also occur on the property. A grab sample from one of these veins returned no anomalous gold value.

Hudson Bay Exploration and Development Company Limited

Between 1972 and 1973, Hudson Bay Exploration and Development Company Limited conducted an exploration program on seven claim groups; three of these, groups B, C and D, were in the map area.

The exploration program included geological, ground magnetic and electromagnetic surveys. A diamond-drilling program, comprising 10 drill holes totalling 1423 feet on the claim groups within the map area, was undertaken to test geophysical conductors. Only minor sulphide mineralization was noted in drill core on all claim groups.

Claim groups B and D (*see* Figure 15; Table 2) are underlain by mafic metavolcanic rocks as indicated by sparse outcrop. Group C is on ground held by E.J. Duchene (*see* above).

Lafontaine, A.

In 1987, A. Lafontaine held two adjoining unsurveyed claims in Oakes Township, north of Long Lake Indian Reserve No. 58.

The property is underlain by intensely deformed quartzofeldspathic sediments, hornblende-bearing intermediate tuff breccia, mafic metavolcanic rocks and gabbro.

A vein of smoky quartz in a hornblende-bearing mafic metavolcanic rock is present on the south side of the Crib Road. Where observed, the quartz vein has an easterly strike, is vertical and up to 0.6 m wide, and carries small quantities of pyrite. A grab sample of the vein material gave an assay value of 65 ppb Au.

Malouf, M.

Two groups of unsurveyed claims, held by M. Malouf, are centred on the Kuhner-Long Lake (Mason and White 1986) and Sopko (Mineral Deposit Files, Ontario Geological Survey) occurrences in Abrey Township.

KUHNER-LONG LAKE OCCURRENCE

The Kuhner-Long Lake occurrence claim group comprises 12 contiguous unsurveyed claims.

The only recorded work, prior to 1986, was by K.C. Kuhner who conducted stripping and trenching over a quartz vein in 1972, although several older trenches, possibly from the 1930s, were located by the field crew.

Ground magnetic and electromagnetic surveys were conducted over the property in 1986, by Phantom Exploration Services Limited for M. Malouf.

The occurrence consists of a quartz vein along an east-striking, 2 to 3 m wide, quartz-feldspar porphyry dike. The dike is hosted by coarse-grained gabbro. The quartz vein contains calcite, tourmaline and, locally, large biotite crystals and euhedral pyrite. A grab sample of pyrite mineralized quartz vein material returned an assay value of 3 ppb Au.

SOPKO OCCURRENCE

The Sopko occurrence claim group comprises 20 contiguous unsurveyed claims within Abrey Township, and 21 claims east of Abrey Township.

The Sopko occurrence is an east-trending sulphide-rich seam, observed to be up to 30 cm wide, composed of pyrite, lesser sphalerite and some chalcopyrite and pyrrhotite. Quartz-tourmaline veins are associated with the sulphide seam. Several smaller sulphide seams parallel the main seam. These seams are hosted by pyrite-bearing sericite schist exposed over a width of 30 to 50 m. The sericite schist appears to mark a sheared contact zone between a hornblende-bearing pebbly sandstone and a small tonalite stock, the Theresa stock, located directly north of the occurrence.

Table 4. Analyses of grab samples from the Sopko occurrence, eastern Abrey Township.

Sample Number	Description of Sample	Au (ppb)	Ag (ppm)	Zn (%)
1240	pyrite seam	4910	4	-
1241	quartz vein mineralized with pyrite	5880	2	-
1242	pyrite seam with sphalerite and some quartz	3650	5	1.35%
1243	pyrite seam with disseminated sphalerite	1220	5	2.42%

The Sopko occurrence was first described in 1963 by the Mining Corporation of Canada Limited, which, under option, undertook geological, and ground magnetic and electromagnetic surveys over the property after some initial trenching uncovered the sulphide seams. The geological and geophysical surveys failed to trace the mineralized zone beyond the discovery trenches.

Ground magnetic and electromagnetic surveys were carried out over the property by Phantom Exploration Services Limited in 1986 for M. Malouf.

The Sopko occurrence has been regarded as a zinc occurrence and is noted as such on a regional compilation map (Pye et al. 1965). Irbe (1964) states: "No close attention was given to the possibility of gold mineralization in quartz veins". Assays obtained from grab samples taken during the present survey indicate high gold potential for this occurrence (*see* Table 4).

McLeod-Cockshutt Gold Mines Limited

McLeod-Cockshutt Gold Mines Limited conducted diamond-drilling programs in the map area in 1958, 1959 and 1965. The 1958-1959 program consisted of diamond-drilling 24 holes, totalling 6473 feet, in Bickle Township north of the map area. The property extended south into Oakes Township. The 1965 drill program, of 15 holes totalling 5001 feet (1524 m) was carried out on a large group of claims in north-central Houck Township. Most of the drill holes encountered minor pyrite, pyrrhotite and chalcopyrite mineralization. Parts of the Houck Township claims were previously drilled by Hanna Mining Company in 1962, and later, by Amoco Canada Petroleum Company Limited in 1981.

Outcrop on the former Houck Township claims is very limited. Pillow basalt and gabbro occur south of Marion Lake. Much quartzofeldspathic rock is described in drill core logs from the 1965 drill program.

McNicoll, B.J.

In 1987, B.J. McNicoll held a block of 13 contiguous unsurveyed claims in the southwestern corner of Croll Township.

Bedrock exposure is very limited on the property; however, it is presumed that much of the property is underlain by granitic rocks of the Croll Lake stock and mafic metavolcanic rocks in the southern part of the claim block.

An airborne magnetic survey was flown over the property in 1987, by H. Ferderber Geophysics Ltd.

Mid-North Engineering Services Limited

In 1987, Mid-North Engineering Services Limited held a block of 15 contiguous unsurveyed claims within, and east of, Abrey Township.

Several companies have explored the area since the 1930s, as it is near the Theresa Mine property east of Abrey Township.

In 1963, The Mining Corporation of Canada Limited conducted geological, and ground magnetic and electromagnetic surveys over the property in connection with activity centered on the Sopko occurrence (*see* M. Malouf).

The most recent work has been a ground electromagnetic survey in 1984 and a soil geochemical survey in 1986, by Mid-North Engineering Services Limited.

The property is underlain by massive hornblende tonalite with associated quartz porphyry intrusions, and by epidotized hornblende-bearing mafic metavolcanic rocks.

Pressman, B.

In 1962, B. Pressman drilled one 123-foot hole south of Suckle Lake in Oakes Township.

This property is entirely underlain by granitic rocks of the Croll Lake stock.

Rissanen, A.E.

A.E. Rissanen held two adjoining unsurveyed claims in Oakes Township, north of Long Lake Indian Reserve No. 58, in 1987.

The property is underlain by garnet-bearing quartzofeldspathic metasediments and hornblende-bearing, highly deformed fragmental metavolcanic rocks.

Roxmark Mines Limited

The company held 36 unsurveyed claims within, and south of, Abrey Township in 1987.

Airborne magnetic and electromagnetic surveys were flown over the property by Aerodat Limited in 1987 for Roxmark Mines Limited. The electromagnetic survey outlined several strong conductors striking east across the property. The magnetic survey delineated an east-striking anomaly south of Abrey Township. This anomaly corresponds to a magnetite-bearing cherty horizon in quartzofeldspathic sandstone observed by the field party. Other rock types outcropping on the property include immature sedimentary rock recrystallized to hornblende schist, and mafic metavolcanic rocks.

Shell Canada Resources Limited

An airborne magnetic survey was flown by Questor Surveys Limited for Shell Canada Resources Limited in November 1978, between Long Lake and Pagwachuan Lake.

In 1979, ground magnetic surveys were conducted over parts of Abrey Township and the McBean Lake area, south of Abrey Township, to better define magnetic features indicated by the airborne survey.

In 1980, Shell Canada Resources Limited carried out a drilling program to test magnetic anomalies. Nine widely spaced holes, totalling 1026 m, were drilled on claims in, and south of, Abrey Township on property held in 1987 by Discovery West Corp. and Roxmark Mines Limited. In several drill holes, thin horizons of pyrite and pyrrhotite mineralization were found.

Theriault, O.

O. Theriault held three unsurveyed claims in the western part of Croll Township in 1987.

The property area has received considerable attention since the 1930s, by companies and individuals investigating quartz-tourmaline veins directly north of the property (*see* Forrester Lake Group; Coulson Exploration Inc.) The most recent recorded work on the property was by O. Theriault; it included two diamond-drill holes, totalling 239 feet, drilled in 1982 and 1983; and two diamond-drill holes, totalling 265 feet, and overburden trenching in 1984.

The claims are underlain by mafic, massive amygdaloidal metavolcanic rocks and gabbro.

Numerous pits and trenches on the property expose sulphide-mineralized shear zones and sulphide-bearing quartz-tourmaline veins. The sulphide mineralization consists of pyrite, chalcopyrite and subordinate molybdenite. Exploration activity on the property has centred on three main showings, referred to as the "old", "new" and "main" showings (Mason and White 1986).

The "old showing", located about 300 m south of Highway 11 on the east side of the Eldee Road, is a quartz-tourmaline vein striking approximately 40° and hosted by gabbro. In parts of the vein, black tourmaline occurs as large masses of slender prismatic crystals. The vein is up to 0.3 m wide and hosts pyrite and minor chalcopyrite mineralization. A grab sample of a sulphide mineralized portion of the vein returned an assay value of 11 ppb Au.

The "new showing" is located 600 m south of Highway 11 on the east side of the Eldee Road. The showing is a 5 m wide shear zone in mafic metavolcanic rocks, striking approximately 070°. Numerous quartz veinlets are found within, and parallel to, the shear zone. The quartz veins are mineralized with pyrite and chalcopyrite which appear to be concentrated along the vein margins. Two grab samples of sulphide-rich quartz vein material gave assay values of 50 and 135 ppb Au respectively.

The "main showing" occurs approximately 900 m south of Highway 11 and 200 m east of the Eldee Road. This showing is a 1 m wide shear zone, striking 035° and dipping 75° to the south. The shear zone is in gabbro and hosts quartz-tourmaline veins mineralized with coarse chalcopyrite and pyrite. Two grab samples, taken by the field party from sulphide-bearing quartz veins, returned assay values of 19.5 ppm and 315 ppb Au respectively. Anomalous, erratic gold contents appear to be associated with the sulphides.

Wilhelm, H.E.

H.E. Wilhelm holds a block of 11 patented claims numbered TB10773 through TB10779, TB10937 through TB10938 and TB10941 through TB10942 in the southeast corner of Croll Township. The claim block covers the Birch Bay gold occurrence (*see* Figure 14) which appears to be the site of the earliest gold exploration in the northern Long Lake area. Mason and White (1986) describe surface exploration on the occurrence, in 1931, on claims originally staked in 1929 by S.B. Watson, G.A. Bagshaw and J. Isherwood. Diamond drilling was conducted on a gold-bearing quartz vein, in 1934, by Birch Bay Gold Mines Limited (*The Northern Miner*, July 19, 1934, p.9). Fairbairn (1938) reports, "Drilling disclosed encouraging values, but the zone was not wide enough to warrant further development". The claims were patented in 1938 (*The Northern Miner*, October 20, 1938, p.20) and have remained idle since.

The Birch Bay occurrence, located on patented claim TB10773, is a quartz vein, up to 0.3 m wide and traceable on surface for 5 m. The vein strikes 080° and dips 75° to the south. The host rock is strongly foliated mafic lapilli tuff. Some tourmaline is present along the wall of the vein and abundant coarse pyrite occurs throughout the vein. A grab sample of pyrite mineralized quartz taken from this location gave an assay value of 28.9 ppm Ag. Fairbairn (1938) also reports visible gold from this occurrence.

Appendix 1: Definitions Of Adopted Terminologies Used In This Report

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Grain Size Classification Of Igneous Rocks

Aphanitic:	grains not visible with hand lens
Fine-grained:	< 1 mm
Medium-grained:	1 mm to 5 mm
Coarse-grained:	> 5 mm

(from Moorhouse 1959, p.160)

Grain Size Classification Of Clastic Sediments (Wentworth Scale of Particle Size)

Gravel	Boulder	> 256 mm
	Cobble	64–256 mm
	Pebble	4–64 mm
	Granule	2–4 mm
Sand	Very coarse sand	1.0–2.0 mm
	Coarse sand	0.5–1.0 mm
	Medium sand	1/4–1/2 mm
	Fine sand	1/8–1/4 mm
	Very fine sand	1/16–1/8 mm
Mudstone	Silt	0.004–0.06 mm
	Clay	< 0.004 mm
Bedding Thickness		
	Thinly laminated	< 0.3 cm
	Thickly laminated	0.3–1 cm
	Very thinly bedded	1–3 cm
	Thinly bedded	3–10 cm
	Medium bedded	10–30 cm
	Thick bedded	30–100 cm
	V. thickly bedded	1–3 m
	Extremely thickly bedded	> 3
Compositions of Igneous Rocks		
	Felsic	< 15% mafic minerals
	Intermediate	15–35% mafic minerals
	Mafic	35–90% mafic minerals
	Ultramafic	> 90% mafic minerals

Appendix 2: Classification Schemes For Volcanoclastic Rocks Used In This Report

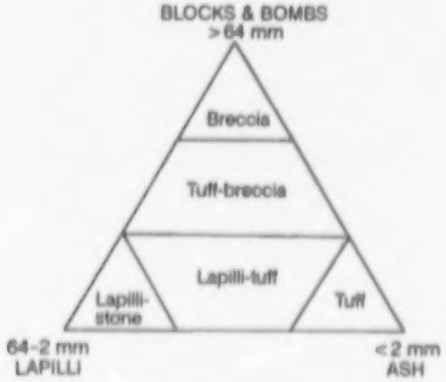
BLOCKS & BOMBS
>64 mm
Breccia
Tuff-breccia
Lapilli-tuff
Lapilli-stone
Tuff
64-2 mm
LAPILLI
<2 mm
ASH

Figure A2-1. The system of classification of pyroclastic rocks *after* Fisher (1966).

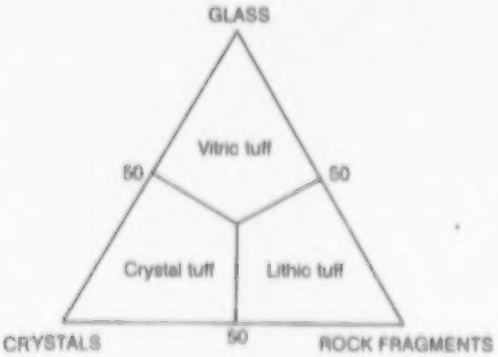
GLASS
Vitric tuff
50
50
Crystal tuff
Lithic tuff
CRYSTALS
50
ROCK FRAGMENTS

Figure A2-2. Classification of tuffs *after* Pettijohn (1975).

Appendix 3: Classification Of Sandstones

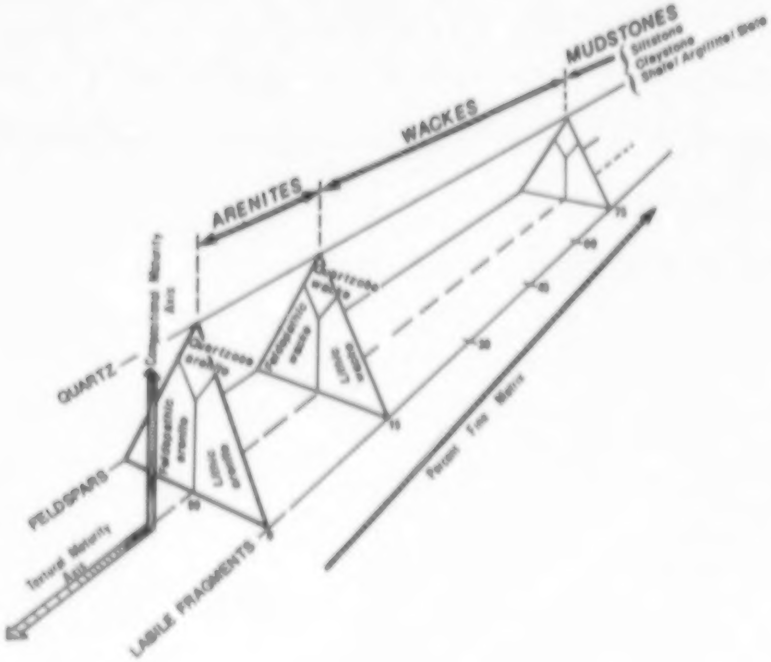
MUDSTONES
Siltstone
Claystone
Shale/ Argillite/ Slate
WACKES
ARENITES
Compositional Maturity Axis
Quartzose arenite
Feldspathic arenite
Lithic arenite
Quartzose wacke
Feldspathic wacke
Lithic wacke
QUARTZ
FELDSPARS
LABILE FRAGMENTS
Textural Maturity Axis
Percent Fine Matrix

Figure A3-1. Simplified classification of sandstones *after* Young (1967). The simplification was made to the arenite and wacke fields for ease of use in the field.

Appendix 4: Rock Geochemistry

A: Descriptions of samples submitted for geochemical analysis.

B: Analytical results for the mafic metavolcanic rocks.

C: Analytical results for the metamorphosed mafic and ultramafic intrusive rocks.

D: Analytical results for the metamorphosed felsic subvolcanic intrusive rocks.

E: Analytical results for the Proterozoic diabase dikes.

F: Analytical results for Proterozoic alkalic dike rocks.

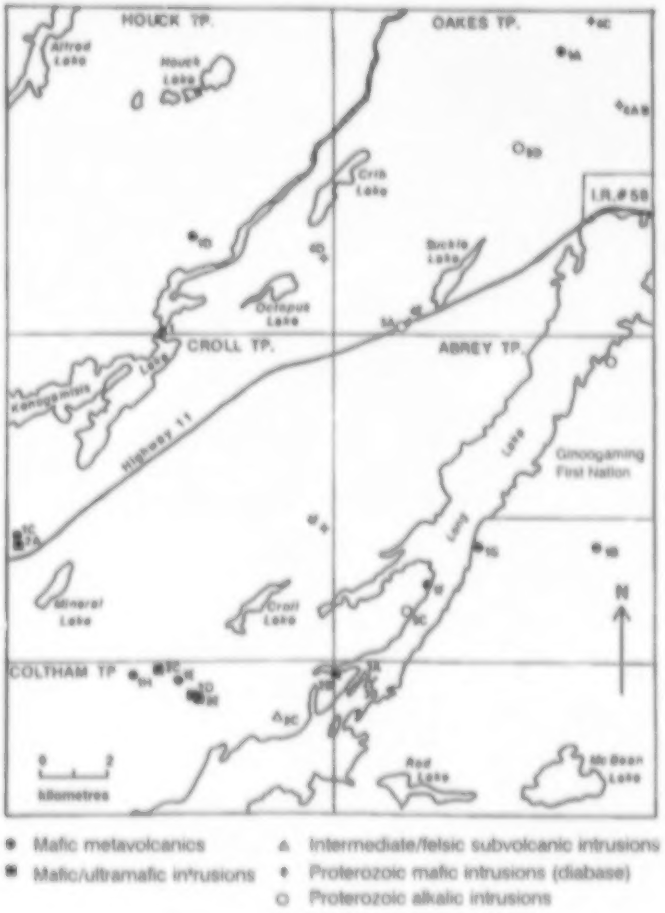
HOUCK TP.
OAKES TP.
Alfred Lake
Houck Lake
Crib Lake
I.R.# 58
Buckle Lake
Octopus Lake
CROLL TP.
ABREY TP.
Kenogamisis Lake
Highway 11
Long Lake
Ginoogaming First Nation
Mineral Lake
Croll Lake
N
COLTHAM TP
Rod Lake
McBean Lake
0 2
kilometres
● Mafic metavolcanics
■ Mafic/ultramafic intrusions
▲ Intermediate/felsic subvolcanic intrusions
♦ Proterozoic mafic intrusions (diabase)
○ Proterozoic alkalic intrusions

Figure A4-1. Location map of rock samples submitted for geochemical analysis. See Appendix 4A for sample descriptions and Appendixes 4B through 4F for analytical values.

APPENDIX 4A: Description of samples submitted to the Geoscience Laboratories, Ontario Geological Survey. Sample locations are shown in Appendix 4A. Analytical values are listed in Appendixes 4B through 4F.

Sample Number (this report)	Field number	Rock Type (Field Descriptions)
Archean Mafic Metavolcanics		
1A	87DUK-0060	Basalt pillowed flow, fine grained, foliated
1B	0150	Basalt flow, massive, fine grained, slight foliation
1C	0177	Basalt pillowed flow, fine grained
1D	0184	Basalt pillowed flow, fine grained
1E	0241	Basalt pillowed flow, fine grained
1F	1121	Basaltic tuff, plag. porphyritic, fine grained
1G	1199	Basaltic flow, massive, fine grained
1H	1211	Basaltic flow, massive, fine grained, biotite-bearing
1J	1226	Basaltic flow, massive, fine grained, slight foliation
Archean Mafic/Ultramafic Intrusions		
2A	0176	Gabbro, massive, melanocratic, medium grained
2B	0217	Pyroxenite, massive, coarse grained
2C	1214	Gabbro, massive, melanocratic, fine grained
2D	GL10	Pyroxenite, massive, melanocratic, coarse grained
2E	GL33	Pyroxenite, massive, melanocratic, coarse grained
Archean Intermediate to Felsic Subvolcanic Intrusions		
3A	0154	Albite porphyry
3B	0157	Albite porphyry
3C	0249A	Albite porphyry
Proterozoic Mafic Dikes		
4A	0041A	Diabase, coarse grained, plagioclase porphyritic
4B	0041B	Diabase, fine grained, non-porphyritic
4C	0055	Diabase, non-porphyrytic, coarse grained
4D	0068B	Diabase, plagioclase porphyritic
4E	0259C	Diabase, fine grained, porphyritic
4F	1152	Diabase, coarse grained, non-porphyritic (?)
Proterozoic Alkalic Rocks		
5A	0259D	Carbonatite (carbonatized peridotite)
5B	1065	Syenite dike, red colour, aphanitic
5C	1120	Syenite, reddish colour, medium grained
5D	2053	Diatreme breccia, heterogeneous rock with heterolithiologic clast composition

APPENDIX 4B: Analytical results for the mafic metavolcanic rocks.

Sample No.	**1A**	**1B**	**1C**	**1D**	**1E**	**1F**	**1G**	**1H**	**1J**
Field No.(*)	**0060**	**0150**	**0177**	**0184**	**0241**	**1121**	**1199**	**1211**	**1226**
Area	**Oakes Tp.**	**Abrey Tp.**	**Croll Tp.**	**Houck Tp.**	**Coltham Tp.**	**Abrey Tp.**	**Abrey Tp.**	**Coltham Tp.**	**Houck Tp.**
Latitude	**49°49′44″**	**49°41′44″**	**49°41′53″**	**49°46′45″**	**49°39′43″**	**49°39′45″**	**49°41′50″**	**49°39′45″**	**49°45′10″**
Longitude	**086°35′10″**	**086°34′18″**	**086°48′42″**	**086°44′18″**	**086°44′38″**	**086°45′44″**	**086°37′20″**	**086°45′44″**	**086°44′58″**
Field Name	**PILLOWED BASALT**	**BASALT**	**PILLOWED BASALT**	**BASALT**	**BASALT**	**BASALT**	**BASALT**	**BASALT**	**BASALT**
SiO_2	48.80	56.00	54.90	51.10	48.90	54.60	58.30	50.10	52.40
Al_2O_3	13.20	16.30	16.40	13.70	13.80	15.50	16.80	12.80	14.10
Fe_2O_3	2.50	1.52	1.40	2.89	1.90	2.25	1.46	2.88	1.80
FeO	12.00	6.66	6.46	8.65	9.32	7.79	5.72	8.39	10.10
MgO	5.08	5.36	4.84	3.67	7.06	4.12	3.29	7.01	4.50
CaO	10.00	7.14	9.10	9.15	10.70	8.51	7.78	11.20	5.55
Na_2O	1.80	3.30	2.86	1.60	2.56	2.89	2.86	2.41	3.11
K_2O	0.65	0.14	0.14	0.24	0.29	0.26	0.33	0.54	0.18
TiO_2	1.93	0.76	0.85	1.30	1.19	1.04	0.70	1.10	1.08
P_2O_5	0.21	0.13	0.14	0.27	0.22	0.14	0.11	0.19	0.14
MnO	0.24	0.14	0.14	0.19	0.17	0.19	0.12	0.23	0.18
CO_2	0.33	0.07	0.12	2.82	0.37	0.24	0.12	0.16	2.57
S	0.20	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04
H_2O^+	2.24	1.89	1.98	3.65	1.79	1.20	1.43	1.62	4.17
H_2O^-	0.05	nd	nd	0.06	nd	0.05	nd	nd	0.05
LOI	1.20	1.10	1.30	5.40	1.10	0.70	0.80	1.20	5.50
TOTAL	99.20	99.40	99.30	99.30	98.30	98.80	99.00	98.60	100.00
S.G.	3.02	2.89	2.88	2.92	3.02	2.94	2.82	3.05	2.83
Ba	206	58	75	111	116	83	120	173	68
Co	49	36	32	35	46	34	27	48	32
Cr	96	163	177	94	480	74	24	362	31
Cu	77	11	49	62	36	13	13	91	69
Ni	40	124	73	63	187	68	47	155	41
Pb	15	13	15	< 10	< 10	< 10	< 10	< 10	< 10
Sc	41	25	27	24	28	28	18	30	34
Sr	174	172	172	249	209	148	137	198	113
Th	< 10	< 10	< 10	< 10	< 10	< 10	11	< 10	< 10
V	371	175	188	185	202	207	150	209	254
Y	29	14	14	23	16	19	13	18	29
Zn	121	115	84	142	108	104	86	143	124
Zr	160	126	125	135	116	146	139	116	152

**Field numbers are abbreviated from the standard OGS sample numbers, e.g., 87DUK-0060*

nd-not detected

APPENDIX 4C: Analytical results for the mafic and ultramafic metamorphosed intrusive rocks.

Sample No.	**2A**	**2B**	**2C**	**2D**	**2E**
Field No.*	**0176**	**0217**	**1214**	**GL10**	**GL33**
Area	**Croll Tp.**	**McBean Lake**	**Coltham Tp.**	**Coltham Tp.**	**Coltham Tp.**
Latitude	**49°41′49″**	**49°39′50″**	**49°39′45″**	**49°39′27″**	**49°39′27″**
Longitude	**086°48′42″**	**086°40′45″**	**086°45′18″**	**086°44′31″**	**086°44′31″**
Field Name	**GABBRO**	**PYROXENITE**	**GABBRO**	**PYROXENITE**	**PYROXENITE**
SiO_2	51.3	46.2	51.2	46.6	46.7
Al_2O_3	13.1	8.64	13.6	14.0	12.2
Fe_2O_3	3.00	2.56	2.10	2.56	2.46
FeO	11.9	8.05	9.45	8.32	8.32
MgO	4.54	14.50	7.28	11.2	11.8
CaO	9.30	11.20	9.10	7.83	8.53
Na_2O	2.91	0.53	2.37	1.84	1.58
K_2O	0.16	0.68	0.72	1.37	1.70
TiO_2	1.20	0.71	1.10	0.68	0.70
P_2O_5	0.08	0.11	0.19	0.17	0.17
MnO	0.24	0.18	0.18	0.18	0.18
CO_2	0.41	1.71	0.24	0.68	1.50
S	0.05	0.01	0.01	0.01	0.01
H_2O^+	1.60	3.44	2.01	3.88	3.61
H_2O^-	nd	0.06	nd	nd	0.06
LOI	0.5	4.2	1.2	3.7	4.4
Total	99.8	98.6	99.5	99.3	99.8
S.G.	3.05	3.02	2.97	2.96	2.94
Ba	50	199	150	347	387
Co	43	59	48	50	52
Cr	14	1410	219	510	750
Cu	156	38	38	79	93
Ni	18	225	160	169	196
Pb	< 10	< 10	< 10	< 10	< 10
Sc	43	28	29	23	32
Sr	108	292	197	522	384
Th	< 10	< 10	< 10	< 10	< 10
V	311	228	194	211	229
Y	24	12	20	13	14
Zn	143	93	109	99	94
Zr	100	69	129	91	87

**Field numbers are abbreviated from the standard OGS sample numbers, e.g., 87DUK-0176*

nd–not detected

APPENDIX 4D: Analytical results for the felsic metamorphosed subvolcanic intrusive rocks.

Sample No.	**3A**	**3B**	**3C**
Field No.*	**0154**	**0157**	**0249A**
Area	**McBean Lake**	**McBean Lake**	**Coltham Tp.**
Latitude	**49°39′36″**	**49°39′40″**	**49°39′05″**
Longitude	**086°40′00″**	**086°39′54″**	**086°42′10″**
Field Name	**FELDSPAR PORPHYRY**	**PORPHYRY**	**FELDSPAR PORPHYRY**
SiO_2	64.0	64.0	64.6
Al_2O_3	17.7	17.6	18.1
Fe_2O_3	0.66	0.20	0.36
FeO	1.53	1.93	1.73
MgO	0.73	0.71	0.68
CaO	3.00	3.01	2.14
Na_2O	7.14	8.34	8.04
K_2O	1.05	0.47	0.71
TiO_2	0.36	0.32	0.39
P_2O_5	0.10	0.09	0.07
MnO	0.03	0.03	0.18
CO_2	1.42	2.05	1.39
S	0.01	0.09	0.08
H_2O^+	1.25	1.10	0.96
H_2O^-	nd	nd	nd
LOI	2.4	2.4	1.9
Total	99.0	98.9	99.4
S.G.	2.69	2.66	2.66
Ba	379	226	337
Co	8	11	7
Cr	12	18	15
Cu	5	26	10
Ni	< 5	< 5	< 5
Pb	12	290	< 10
Sc	1	< 1	< 1
Sr	417	255	203
Th	< 10	< 10	< 10
V	50	48	47
Y	2	3	< 2
Zn	28	57	64
Zr	95	84	85

**Field numbers are abbreviated from the standard OGS sample numbers, e.g., 87DUK-0154*

nd-not detected

APPENDIX 4E: Analytical results for the Proterozoic diabase dikes.

Sample No.	**4A**	**4B**	**4C**	**4D**	**4E**	**4F**
Field No.*	**0041A**	**0041B**	**0055**	**0068B**	**0259C**	**1152**
Area	**Oakes Tp.**	**Oakes Tp.**	**Oakes Tp.**	**Houck Tp.**	**Oakes Tp.**	**Croll Tp.**
Latitude	**49°48′51″**	**49°48′51″**	**49°50′15″**	**49°46′25″**	**49°45′22″**	**49°42′07″**
Longitude	**086°33′35″**	**086°33′35″**	**086°34′25″**	**086°41′04″**	**086°41′07″**	**086°41′04″**
Field Name	**COARSE-GRAINED DIABASE PLAGIOCLASE PORPHYRY**	**FINE-GRAINED DIABASE APHYRIC**	**DIABASE APHYRIC**	**DIABASE PORPHYRITIC**	**DIABASE PORPHYRITIC**	**DIABASE**
SiO_2	50.20	45.80	50.00	48.80	48.70	50.10
Al_2O_3	14.70	12.40	14.40	13.30	15.10	13.50
Fe_2O_3	3.20	5.60	4.00	2.50	2.81	2.60
FeO	10.60	10.60	10.70	12.00	8.72	11.20
MgO	4.78	5.15	4.83	4.87	6.83	5.18
CaO	9.59	9.44	9.66	9.77	11.10	9.40
Na_2O	2.40	2.62	2.40	1.85	1.93	2.27
K_2O	0.62	0.49	0.47	0.66	0.32	0.76
TiO_2	1.33	2.97	1.62	2.59	0.96	1.83
P_2O_5	0.15	0.32	0.16	0.31	0.07	0.22
MnO	0.21	0.21	0.22	0.33	0.18	0.22
CO_2	0.13	1.88	0.33	0.09	1.08	0.97
S	0.09	0.31	0.03	0.24	0.03	0.17
H_2O^+	1.61	1.69	0.89	2.23	0.84	1.77
H_2O^-	0.05	0.06	0.11	0.08	00.00	0.14
LOI	0.60	2.40	0.30	1.60	1.30	1.50
TOTAL	99.60	99.50	99.80	99.60	98.70	100.30
S.G.	3.01	3.04	3.03	3.05	3.02	3.05
Ba	231	188	175	258	340	328
Co	47	56	50	52	46	46
Cr	81	176	90	76	224	95
Cu	161	165	184	81	153	62
Ni	49	93	53	43	122	42
Pb	11	16	12	< 10	< 10	< 10
Sc	37	29	40	38	35	40
Sr	138	389	152	223	131	210
Th	< 10	10	10	< 10	< 10	12
V	342	439	400	423	293	342
Y	30	29	31	30	18	29
Zn	132	155	144	69	96	140
Zr	147	224	150	188	84	178

Field numbers are abbreviated from the standard OGS sample numbers, e.g., 87DUK-0041A

APPENDIX 4F: Analytical results for Proterozoic alkalic dike rocks.

Sample No.	**5A**	**5B**	**5C**	**5D**
Field No.*	**0259D**	**1065**	**1120**	**2053**
Area	**Oakes Tp.**	**Ginoogaming F.N.**	**Abrey Tp.**	**Oakes Tp.**
Latitude	**49°45′22″**	**49°44′52″**	**49°40′43″**	**49°48′15″**
Longitude	**086°41′07″**	**086°33′55″**	**086°38′45″**	**086°36′06″**
Field Name	**ALTERED PERIDOTITE**	**SYENITE DYKE**	**SYENITE DYKE**	**DIATREME BRECCIA**
SiO_2	21.60	62.8	45.4	53.5
Al_2O_3	2.31	15.2	16.5	17.3
Fe_2O_3	2.70	4.91	6.85	9.36
FeO	9.18	0.79	8.42	nd
MgO	17.00	0.05	3.48	2.65
CaO	9.72	2.65	5.62	10.5
Na_2O	0.41	4.78	4.78	2.34
K_2O	2.21	4.82	1.16	0.56
TiO_2	2.58	0.14	1.18	0.86
P_2O_5	0.81	0.05	1.89	0.26
MnO	0.18	0.08	0.23	0.11
CO_2	30.70	1.56	0.83	0.43
S	0.10	0.06	0.12	0.01
H_2O^+	0.43	0.09	3.45	nd
H_2O^-	0.05	nd	nd	nd
LOI	29.00	2.1	3.5	2.2
TOTAL	99.90	98.0	99.9	99.6
S.G.	3.04	ND	ND	ND
Ba	385	170	1700	nd
Co	76	< 5	34	19
Cr	730	< 10	< 10	282
Cu	86	44	88	10
Nb	nd	nd	nd	6
Ni	620	< 5	< 5	36
Pb	38	55	< 10	< 10
Sc	17	3	14	nd
Sr	744	119	1306	506
Th	38	146	27	< 10
U	7.3	nd	nd	nd
V	179	1	87	nd
Y	28	91	36	42
Zn	102	88	137	53
Zr	696	1153	225	181

**Field numbers are abbreviated from the standard OGS sample numbers, e.g., 87DUK-0259D*

nd-not detected

ND-not determined

References

Amukun, S.E. 1980. Geology of the Conglomerate Lake area, District of Thunder Bay; Ontario Geological Survey Report 197, 101p.

Anglin, C.D. and Franklin, J.M. 1985. Gold mineralization in the Beardmore–Geraldton area of northwestern Ontario: structural considerations and the role of iron formation; *in* Current Research, pt.A, Geological Survey of Canada, Paper 85-1A, p.193-201.

Anglin, C.D., Franklin, J.M., Loveridge, W.D., Hunt, P.A. and Osterberg, S.A. 1988. Use of zircon U-Pb ages of felsic intrusive and extrusive rocks in eastern Wabigoon Subprovince, Ontario, to place constraints on base metal and gold mineralization; *in* Radiometric Age and Isotopic Studies, Geological Survey of Canada, Paper 88-Z, p.109-115.

Archibald, C.W. 1983. Summary report Ferau Resources Inc. Croll, Abrey, Coltham townships and McBean Lake area, Ontario; Resident Geologist's Files, Resident Geologist's office, Beardmore-Geraldton District, Thunder Bay, 18p.

Ayres, L.D. 1969. Early Precambrian stratigraphy of part of Lake Superior Provincial Park, Canada and its implications for the origin of the Superior Province; unpublished PhD thesis, Princeton University, Princeton, New Jersey, 399p.

Barrett, T.J. and Fralick, P.W. 1985. Sediment redeposition in Archean iron formations: examples from the Beardmore–Geraldton greenstone belt, Ontario; Journal of Sedimentary Petrology, v.55, p.205-212.

——1989. Turbidites and iron formations, Beardmore–Geraldton, Ontario: application of a combined ramp/fan model to Archean clastic and chemical sedimentation; Sedimentology, v.36, p.221-234.

Beakhouse, G.P. 1989. Geology of the Grenville Lake area, District of Thunder Bay; Ontario Geological Survey, Report 246, 75p.

Beakhouse, G.P. and Chevalier, P. 1983a. Precambrian geology of Fulford and McQuesten townships, Thunder Bay District; Ontario Geological Survey, Preliminary Map P.2593, scale 1:15 840.

——1983b. Precambrian geology of Kirby Township, Thunder Bay District; Ontario Geological Survey, Preliminary Map P.2592, scale 1:15 840.

Blackburn, C.E. and Mackasey, W.O. 1977. Nature of the Quetico-Wabigoon boundary in the DeCourcey–Smiley lakes area, northwestern Ontario: discussion; Canadian Journal of Earth Sciences, v.14, p.1959-1961.

Borradaile, G.J. and Poulsen, K.H. 1981. Tectonic deformation of pillow lava; Tectonophysics, v.79, p.17-26.

Bouma, A.H. 1962. Sedimentology of some flysch deposits; Elsevier, Amsterdam, 168p.

Brandt, R.T., Gross, G.A., Gruss, H. Semenenko, N.P. and Dorr, J.V.N. 1972. Problems of nomenclature for banded ferruginous-cherty sedimentary rocks and their metamorphic equivalents; Economic Geology, v.67, p.682-684.

Bruce, E.L. 1935. Little Longlac Gold area; Ontario Department of Mines, Annual Report, 1935, v.44, pt.3, 60p.

Buck, S. 1986. Structural studies and gabbro mylonitization within the Barton Bay deformation zone, Geraldton, Ontario; unpublished MSc thesis, Brock University, St. Catharines, 172p.

Buck, S. and Williams, H.R. 1984. Structural studies in the Geraldton area; *in* Summary of Field Work 1984, Ontario Geological Survey, Miscellaneous Paper 119, p.208-211.

Burrows, A.G. 1917. Longuelac to Jellicoe and Orient Bay; Ontario Bureau of Mines, Annual Report, 1917, v.26, 20p.

Coleman, A.P. 1909. Iron ranges of Nipigon District; Ontario Department of Mines, Annual Report, 1909, v.18, pt.1, p.141-153.

Davis, D.W. and Sutcliffe, R.H. 1985. U-Pb ages from the Nipigon Plate and northern Lake Superior; Geological Society of America Bulletin, v.96, p.1572-1579.

Deer, W.A., Howie, R.A. and Zussman, J. 1962. Rock-forming Minerals, v.5; Longman, Green and Co. Ltd., London, 371p.

Devaney, J.R. 1987. Sedimentology and stratigraphy of the northern and central metasedimentary belts in the Beardmore–Geraldton area of northern Ontario; unpublished MSc thesis, Lakehead University, Thunder Bay, Ontario, 227p.

Devaney, J.R. and Williams, H.R. 1989. Evolution of an Archean subprovince boundary: a sedimentological and structural study of part of the Wabigoon–Quetico boundary in northern Ontario; Canadian Journal of Earth Sciences, v.26, p.1013-1026.

Easton, R.M. 1986. Geochronology compilation map for Ontario: sheet 4, west central Ontario, all isotopic systems; Ontario Geological Survey, Preliminary Map P.2843, scale 1:1 013 760.

Fahrig, W.F. 1987. The tectonic settings of continental mafic dike swarms: failed arm and early passive margin; *in* Mafic Dike Swarms, Geological Association of Canada, Special Paper 34, p.331-348.

Fairbairn, H.W. 1938. Geology of the northern Long Lake area, Thunder Bay District; Ontario Department of Mines, Annual Report, 1937, v.46, pt.3, p.1-22.

Fisher, R.V. 1966. Rocks composed of volcanic fragments and their classification; Earth Science Reviews, v.1, p.287-298.

Fralick, P.W. and Barrett, T.J. 1983. The sedimentology of banded iron formation in the Beardmore–Geraldton greenstone belt: A preliminary appraisal; *in* Summary of Field Work 1983, Ontario Geological Survey, Miscellaneous Paper 116, p.204-206.

Gartner, J.F. 1979. Longlac Area (NTS 42E/NE), District of Thunder Bay; Ontario Geological Survey, Northern Ontario Engineering Geology Terrain Study 28, 21p.

Goodwin, A.M. 1962. Structure, stratigraphy and origin of iron formations, Michipicoten area, Algoma District, Ontario, Canada; Geological Society of America Bulletin, v.73, p.561-586.

——1970. Metallogenic evolution of the Canadian Shield; *in* Geology and Economic Minerals of Canada, Geological Survey of Canada, Economic Geology Report Number 1, p.156-162.

——1973. Archean iron-formations and tectonic basins of the Canadian Shield; Economic Geology, v.68, p.915-933.

——1977. Archean basin-craton complexes and the growth of Precambrian shields; Canadian Journal of Earth Sciences, v.14, p.2737-2759.

Gross, G.A. 1973. The depositional environment of principal types of Precambrian iron-formations; *in* Genesis of Precambrian Iron and Manganese Deposits, Unesco Earth Science, v.9, p.15-21.

——1980. A classification of iron formations based on depositional environments; Canadian Mineralogist, v.18, p.215-222.

Heaman, L.M. and Machado, N. 1987. Isotope geochemistry of the Coldwell alkaline complex: 1. U-Pb studies on accessory minerals; *in* Program with Abstracts, Geological Association of Canada–Mineralogical Associaton of Canada, v.12., p.54.

Horwood, H.C. and Pye, E.G. 1955. Geology of Ashmore Township, Thunder Bay District; Ontario Department of Mines, Annual Report, 1951, v.60, pt.5, 105p.

Hurley, P.M. 1958. Age investigations of syenites from Coldwell, Ontario; Massachusetts Institute of Technology, 6th Annual Program Report MIT-1381-6, p.63-69.

Innes, D.G. and Ayres, L.D. 1970. Caramat–Pagwa River sheet, Algoma, Cochrane and Thunder Bay districts; Ontario Department of Mines, Map 2202, scale 1:253 440.

Irbe, J.G. 1964. Geological report on the Sopko option and Longlac group no. 1, Longlac area, Ontario. The Mining Corporation of Canada Limited; Resident Geologist's files, Resident Geologist's office, Beardmore-Geraldton District, Thunder Bay, 6p.

Irvine, T.N. and Baragar, W.R.A. 1971. A guide to the chemical classification of the common volcanic rocks; Canadian Journal of Earth Sciences, v.8, p.523-548.

Jensen, L.S. 1976. A new cation plot for classifying subalkalic volcanic rocks; Ontario Division of Mines, Miscellaneous Paper 66, 22p.

Johnston, F.J. 1968. Molybdenum Deposits of Ontario; Ontario Department of Mines, Mineral Resources Circular No.7, 98p.

Kehlenbeck, M.M. 1976. Nature of the Quetico–Wabigoon boundary in the DeCourcey–Smiley area, northwestern Ontario; Canadian Journal of Earth Sciences, v.13, p.737-748.

—— 1986. Folds and folding in the Beardmore–Geraldton fold belt; Canadian Journal of Earth Sciences, v.23, p.158-171.

Kresz, D.U. and Zayachivsky, B. 1987. Northern Long Lake area, District of Thunder Bay; *in* Summary of Field Work and Other Activities 1987; Ontario Geological Survey, Miscellaneous Paper 137, p.93-98.

—— 1989. Precambrian geology, Barbara, Meader and Pifher townships; Ontario Geological Survey, Report 270, 91p.

Kresz, D.U., Zayachivsky, B. and Oiye, H.S. 1990a. Precambrian geology, northern Long Lake area, northern part; Ontario Geological Survey, Map 2538, scale 1:20 000.

—— 1990b. Precambrian geology, northern Long Lake area, southern part; Ontario Geological Survey, Map 2539, scale 1:20 000.

Laird, H.C. 1936. The western part of the Sturgeon River area; Ontario Department of Mines, Annual Report, 1936, v.45, pt.2, p.60-117.

Lajoie, J. 1979. Volcaniclastic rocks; *in* Facies Models, Geological Association of Canada, Geoscience Canada, Reprint Series 1, p.191-200.

Lavigne, M.J., Jr. 1983. Gold deposits of the Geraldton area; *in* Summary of Field Work, Ontario Geological Survey, Miscellaneous Paper 116, p.198-200.

Lister, G.S. and Snoke, A.W. 1984. S-C mylonites; Journal of Structural Geology, v.6, no.6, p.617-638.

Macdonald, A.J. 1982. The MacLeod Cockshutt and Hard Rock mines, Geraldton: examples of an iron formation-related gold deposit; *in* Summary of Field Work 1982, Ontario Geological Survey, Miscellaneous Paper 106, p.188-191.

—— 1983a. A re-appraisal of the Geraldton gold camp; *in* Summary of Field Work 1983, Ontario Geological Survey, Miscellaneous Paper 116, p.194-197.

—— 1983b. Iron formation–gold association: evidence from Geraldton area; *in* The Geology of Gold in Ontario, Ontario Geological Survey, Miscellaneous Paper 110, p.75-82.

—— 1984. Gold mineralization in Ontario: I. The role of banded iron formation in Chibougamau – stratigraphy and mineralization; Canadian Institute of Mineralogy, Special Volume 34, p.412-430.

Macdonald, R.D. 1938. Geology of the Pagwachuan Lake area, Thunder Bay District; Ontario Department of Mines, Annual Report, 1937, v.46, pt.3, p.23-40.

—— 1942. Geology of the Kenogamisis River area, Thunder Bay District; Ontario Department of Mines, Annual Report, 1940, v.49, pt.7, p.12-28.

—— 1943. Geology of the Hutchison Lake area, District of Thunder Bay; Ontario Department of Mines, Annual Report, 1941, v.50, pt.3, 21p.

Mackasey, W.O. 1972. Sturgeon River metavolcanic-metasedimentary formations in the Beardmore–Geraldton area; *in* The Precambrian Rocks of the Atikokan–Thunder Bay–Marathon Area, Guidebook for Field Excursion C34; International Geological Congress XXIV, p.47-74.

—— 1975. Geology of Dorothea, Sandra and Irwin townships, District of Thunder Bay; Ontario Division of Mines, Geological Report 122, 83p.

—— 1976. Geology of Walters and Leduc townships, District of Thunder Bay, Ontario Division of Mines, Geological Report 149, 58p.

Mackasey, W.O., Blackburn, C.E. and Trowell, N.F. 1974. A regional approach to the Wabigoon–Quetico belts and its bearing on exploration in northwestern Ontario; Ontario Division of Mines, Miscellaneous Paper 58, 29p.

Mackasey, W.O., Edwards, G.R. and Cape, D.F. 1976. Legault Township, District of Thunder Bay; Ontario Division of Mines, Preliminary Map P.1191, scale 1:15 840.

Mason, J.K. and McConnell, C.D. 1983. Gold mineralization in the Beardmore–Geraldton area; *in* The Geology of Gold in Ontario, Ontario Geological Survey, Miscellaneous Paper No.110, p.84-97.

Mason, J. and White, G. 1986. Gold occurrences, prospects and deposits of the Beardmore–Geraldton area, districts of Thunder Bay and Cochrane; Ontario Geological Survey, Open File Report 5630, 630p.

Ministry of Natural Resources 1970. Long Lake (north half), Geraldton District, Longlac Division, bathymetric chart. Surveyed by J.O'Connor, D. Stashick, M. Ward, G. Lee 1968, 1969.

Moorehouse, W.W. 1959. The study of rocks in thin section; Harper and Row, New York, 514p.

Ontario Department of Mines–Geological Survey of Canada 1963a. Geraldton, Thunder Bay District; Ontario Department of Mines–Geological Survey of Canada, Map 2150G, scale 1:63 360.

—— 1963b. Longlac, Thunder Bay and Cochrane districts; Ontario Department of Mines–Geological Survey of Canada, Map 2151G, scale 1:63 360.

—— 1965. Longlac, Ontario; Ontario Department of Mines–Geological Survey of Canada, Map 7102G, scale 1:250 000.

Ojakangas, R.W. 1985. Review of Archean clastic sedimentation, Canadian Shield: major felsic volcanic contributions to turbidite and alluvial fan-fluvial facies associations; *in* Evolution of Archean Supracrustal Sequences, Geological Association of Canada Special Paper 28, p.23-47.

Paikin, S. 1946. Geology of the Making Ground River claims of Independent Mining Corporation; assessment files, Assessment Files Research Office, Ontario Geolgical Survey, 16p.

Parliament, H. 1962. Geology of the Goodwin claims, Houck Township, Thunder Bay Mining District, Ontario, Scope Mining and Exploration Consultants Limited; assessment files, Assessment Files Research Office, Ontario Geological Survey, 6p.

Pettijohn, F.J. 1975. Sedimentary rocks, 3rd ed.; Harper and Row, New York, 628p.

Phillips, G.N., Groves, D.I. and Martyn, J.E. 1984. An epigenetic origin for Archean banded iron-formation-hosted gold deposits; Economic Geology, v.79, p.162-171.

Pye, E.G. 1952. Geology of Errington Township, Little Long Lac area, Thunder Bay District; Ontario Department of Mines, Annual Report, 1951, v.60, pt.6, 140p.

Pye, E.G., Harris, F.R., Fenwick, K.G. and Baillie, J. 1965. Tashota–Geraldton sheet, Thunder Bay and Cochrane districts; Ontario Department of Mines, Map 2102, scale 1:253 440.

Ramsay, J.G. and Huber, M.I. 1983. The techniques of modern structural geology, v.1: strain analysis; Academic Press, London, 307p.

Reilly, B.A. and Williams, H.R. 1986. Structural geology of the Paint Lake fault system in Walters, Leduc and Legault townships of northwestern Ontario; Geological Association of Canada, Annual Meeting Abstracts, v.11, p.117.

Sirola, T.J. 1940. Report on surface work and diamond drilling, Burroughs Syndicate, Long Lac area, Ontario; assessment files, Assessment Files Research Office, Ontario Geological Survey, 10p.

Stockwell, C.H. 1964. Fourth report on structural provinces, orogenies and time-classification of rocks of the Canadian Precambrian Shield; *in* Age Determinations and Geological Studies, Geological Survey of Canada, Paper 64-17 (Part II), 29p.

Stott, G.M. 1984a. Geraldton sheet, Thunder Bay and Cochrane districts; Ontario Geological Survey, Preliminary Map P.241 (Revised), scale 1:126 720.

——1984b. Lake Nipigon sheet, Thunder Bay District; Ontario Geological Survey, Preliminary Map P.257 (Revised), scale 1:126 720.

Streckeisen, A. 1976. To each plutonic rock its proper name; Earth-Science Reviews, v.12, p.1-33.

——1979. Classification and nomenclature of volcanic rocks, lamprophyres, carbonatites and melilitic rocks: recommendations and suggestions of the IUGS Subcommission on the Systematics of Igneous Rocks; Geology v.7, no.7, p.331-335.

Sutcliffe, R.H. 1986. The petrology, mineral chemistry and tectonics of the Proterozoic rift-related igneous rocks at Lake Nipigon, Ontario; unpublished PhD thesis, University of Western Ontario, London, Ontario, 325p.

Thorleifson, L.H. and Kristjansson, F.J. 1987. Gold grains in surface till samples, Beardmore–Geraldton Area, District of Thunder Bay; Ontario Geological Survey, Preliminary Map P.3105, scale 1:100 000.

Walker, R.G. 1975. Generalized facies models for resedimented conglomerates of turbidite association; Geological Society of America Bulletin, v.86, p.737-748.

——1978. A critical appraisal of Archean basin-craton complexes; Canadian Journal of Earth Sciences, v.15, p.1213-1218.

——1984. Turbidites and associated coarse clastic deposits; *in* Facies Models, Geoscience Canada, Reprint Series 1, p.171-188.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Delabio, R.N.D. 1974. Age determinations and geological studies, K-Ar isotopic ages, report 12; Geological Survey of Canada, Paper 74-2, 72p.

White, S.H., Burrows, S.E., Carreras, J., Shaw, N.D. and Humphreys, F.J. 1980. On mylonites in ductile shear zones; Journal of Structural Geology, v.2, p.175-187.

Williams, H.R. 1986. Structural studies in the Beardmore–Geraldton belt, northern Ontario; *in* Geoscience Research Grant Program, Summary of Research, 1985–1986, Ontario Geological Survey, Miscellaneous Paper 130, p.138-146.

——1987. Ontario Geoscience Research Program, Grant No.242: structural studies in the Wabigoon and Quetico subprovinces; Ontario Geological Survey, Open File Report 5668, 163p.

Winkler, W.G.F. 1979. Petrogenesis of metamorphic rocks, 5th ed.; Springer-Verlag, New York, 348p.

Young, G.M. 1967. Sedimentology of Lower Visean? rocks in the western part of the Ballina and Donegal Syndires, northwestern Ireland; unpublished PhD thesis, University of Glasgow, Glasgow, Scotland, 204p.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

Conversion from SI to Imperial			Conversion from Imperial to SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy) per ton (short)	20.0	pennyweights per ton (short)
1 pennyweight per ton (short)	0.05	ounces (troy) per ton (short)

Note: Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries, published by the Mining Association of Canada in co-operation with the Coal Association of Canada.

MAPS
NOT
FILMED

CARTES
OMISES